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SPLENIC CYSTS WITH REPORT OF A CASE OF A LARGE UNILOCULAR CYST OF RAPID GROWTH*

RICHARD P. BELL, JR., M.D.
STAUNTON, VIRGINIA

Almost invariably, reports on splenic cysts state that they are rare, but we can find no reference as to the rapidity of growth, particularly in large true cysts of the spleen. It is for this reason, in addition to the rarity of such cysts, that we wish to report the following case.

CASE REPORT

A 30-year-old, single, white, female was admitted to the gynecological service of King’s Daughters’ Hospital on October 13, 1950. She had had one serious illness which was diagnosed as undulant fever 3 years before this admission. There were no operations except for tonsillectomy in early 1950. Her family history was negative and review of the systems revealed no abnormalities.

The present illness consisted of severe lower abdominal pain of 6 months’ duration, coming on just before periods and lasting during the flow. The flow was excessive, being half again as much as previously. The bleeding was not prolonged or irregular, the menses lasting 5 to 6 days with a 28-day intervals. She had been followed for 2 months by a competent gynecologist who decided to admit her to the hospital for examination under anesthesia. A mass had been felt intermittently in the left lower quadrant on pelvic examination, but the office examination was not completely satisfactory.

Physical examination on this admission showed a well developed and well nourished white woman of 30 years of age. All her upper teeth had been removed apparently because of abscesses. The eyes, ears, nose and throat were negative. The neck showed no masses. There were no enlarged lymph nodes and the trachea was in the midline. There was no sign of thyroid enlargement. The lungs were clear to percussion and auscultation. The heart was normal in size and blood vessels were normal. The blood pressure was 130/80. The breasts were flat, small and negative. The abdomen was soft, flat, relaxed and non-tender and there were no palpable abdominal masses. The costo-vertebral angles were negative. The external genitalia were normal. The pelvic examination under anesthesia showed an intact hymen which admitted one finger. The glands were negative and there was no significant discharge from the vagina. The cervix was firm, free and in good condition. The uterus was normal size and inclined somewhat to the right. The adnexae showed a clear right side, but there was a fixed, cystic mass 6 cm. in diameter on the left.

Routine blood examination revealed a hemoglobin of 78 per cent, 12.2 Gm.; a normal white blood count and a negative serology. The urine was negative. No further laboratory studies were done on this admission.

The preoperative impression was ovarian cyst, left, and possible endometriosis.

Following pelvic examination a dilatation and curettage of the uterus was done with biopsy of the cervix. This was followed by pelvic laparotomy which showed extensive bilateral endometriosis of the ovaries with a large chocolate, hemorrhagic cyst on the left side. An exploration of the abdomen, including the spleen, revealed no masses. A bilateral oophorectomy and routine appendectomy were performed.

The patient was followed carefully, because of severe symptoms after castration, through February, 1951, at which time she was discharged feeling well. She had no further trouble until she returned on May 2, 1951, about 6 months after the oophorectomy, complaining of the sensation of a mass in her upper abdomen of about 6 weeks’ duration, and stated that she felt full after very little food. There was a sensation of dull, upper abdominal discomfort, which was aching in character. Other than inability to take much food,
vague discomfort, and 10 pounds weight loss since last admission, there were no specific abdominal complaints. The physical examination was negative except for the abdomen, which showed a sense of resistance over the left costal margin with the patient on the right side. No specific dullness could be made out.

Laboratory examination revealed 12.6 Gm., 81 per cent hemoglobin; 4.08 red blood cells; 6,500 white blood cells; basophils 0; eosinophil 1 per cent; myelocytes, 0; juveniles 0; stabs, 0; segs, 68 per cent; lymphs, 31 per cent, and monos, 0. The urine examination was negative. A barium meal showed the stomach to be displaced downward and the right by a large mass in the left upper quadrant of the abdomen with slight elevation of the diaphragm on the left. A barium enema was negative except for the abdomen, which showed a sense of resistance over the left costal margin with the patient on the right side. No specific dullness could be made out.

The patient returned again to the hospital and was explored on October 18, 1951, five months later, for severe intermittent sharp lower abdominal pain and right upper quadrant discomfort. It was found, to the regret of the gynecologist, that the right fallopian tube was very adherent at its distal end to the right colonic mesentry near the hepatic flexure. The kidney was also ptosed on this side. A total hysterectomy and salpingectomy were performed. A nephropexy of the right kidney was done.

Subsequent roentgenograms along with the latest exploration have shown the stomach, kidneys and diaphragm to be in their normal relationships. We have concluded, therefore, that between the two operations of October 10, 1950, and May 5, 1951, this tumor had enlarged from a very small non-palpable cyst to a very large cyst filling the entire left subdiaphragmatic space. There is a remote possibility that the cyst was not in the process of formation at the time of the first operation.

Reference in the literature has been made to the role of menstruation and pregnancy in the etiology of splenic cysts. Cysts occur most frequently in women and are more often in the childbearing age, particularly those with menstrual irregularity (Tamaki). This has been explained by the fact that the spleen becomes more congested during menstruation and pregnancy. Tamaki, quoting Frank, related a case history of a large marsupialized cyst which discharged blood at each menstrual period. There are other reports in the literature concerning the relation of menstruation to splenic cysts. Unconvincing as these reports may be, it seems worth-while to consider that, as a remote possibility, endometriosis could be in some way linked to the formation of the cyst we report.

The symptoms of the splenic cyst are vague. Passalacqua has stated that local...
SPLENIC CYSTS

Laserzation at the upper pole of the spleen will give predominantly pulmonary difficulties, while at the lower pole the symptoms are predominantly abdominal. We do not believe that this is a good rule. Most of the cysts reported in the literature, regardless of the location, give abdominal symptoms. Those abdominal symptoms consist of fullness, epigastric pain and other vague digestive disturbances. However, with marked splenic flexure downward. Duby, quoting Benton, states that the downward displacement of the splenic flexure is practically pathognomonic of splenic cysts. In general splenomegaly from other causes does not result in depression of the splenic flexure of the colon. Tumors of the retro-peritoneal organs push the colon forward. Pancreatic cysts, kidney tumors and ovarian cysts are usually lower in the abdomen.

Fig. 1.—Lateral view showing displacement of the stomach.
Fig. 2.—Downward displacement of the splenic flexure of the colon. This is stated to be practically pathognomonic of splenic cysts.
Fig. 3.—Depression of the left kidney, with the small triangular spleen on the lateral and superior side.

Strode et al. classify positions of cysts as follows: lower pole, 26 per cent; convex surface, 18 per cent; concave surface, 18 per cent; hilus, 14 per cent; anterior border, 12 per cent; upper pole, 9 per cent; and posterior border, 3 per cent. We do not believe that there is any correlation between the position of these cysts and the symptoms present in the cases we have reviewed.

The most widely accepted classification of splenic cysts is that of McClure and Altemeier (from Duggan) in 1942 which is as follows:

I. True Cysts (lined by specific secreting membrane).

A. Epithelial
It is believed that splenomegaly associated with these diseases more readily subject the organ to trauma. Fowler presented 70 cases from his series of 137, who gave a history of antecedent malaria (Aiengar). Tamaki points out embolism, or thrombosis of the splenic vessels as a possible antecedent cause of cysts. He also mentions endarteritis of the splenic parenchyma with possible cystic change.

It is thought that some cysts develop from inclusions of infolded peritoneum which are either the result of trauma or inflammation. These cysts are distinguished from the neoplastic types such as those developing from lymphangiomata and hemangiomata. Denneen quotes Baccelli, who states that hemorrhagic cysts can form a capsule with an inner lining of cells; Lubarsch (from Denneen) disagrees by saying that no true cell lining is present in the hemorrhagic type of cyst nor can it form. DeLee, quoted by Whitham and others, has shown that hormonal changes occur during menstruation and pregnancy which alter the size and cause congestion of the spleen. He suggests that trauma during these phases of congestion and enlargement may induce hematoma or cystic changes. We have already dwelt upon the influence of menstrual disorders in our case report.
Due to the rarity of splenic cysts, it is fitting to bring the number and types of cysts up to date with each report. Andral of France was the first to report a splenic cyst in 1829. Fowler brought the collection up to date in 1939 with a total of 137 reported cases. McClure and Altemeier added a collection of 11 splenic cysts in the literature from February, 1941, and reported a case of their own. Harmer and Chalmers reviewed the literature in 1944, bringing the instance of reported cases to 162. Martin, Zega and Adamson added 21 more cases and reported a case of their own in May, 1950, bringing the total to 184 cases. Whitham, Garlinghouse, Tanner and Moessner reported a case in May, 1951, while Callahan and Shellito reported a case in June, 1951. At the same time Strohl and Sarver reported another case, bringing the total to 187 cases. The case we report, we believe, is the 188th through the year 1951.

Of the true cysts of the spleen, the epidermoid cyst is the rarest. Raderkovich reports the latest case, as far as we can determine, in February, 1950, bringing the total to 11 in the literature. With regard to embryology, it is difficult to explain the presence of an epidermoid-like layer in the spleen. However, Linn and Ellias suggest that the epidermoid layer arises by metaplasia from mesothelial cells having their origin in the primitive coelomic cavity. This, we believe, is the most plausible explanation, although others have been advanced.

The next most rare subdivision of true cysts is the calcified type of which there have been 32 cases reported according to Lustok and Baum in September, 1949, but according to Martin, Zega and Adamson, only 31 of this type have been reported up to May, 1950.

**SUMMARY**

1. A report of the 188th non-parasitic cyst of the spleen is made, emphasizing that rapid growth may occur in an endothelial cyst.
2. Those factors which aid in preoperative diagnosis are discussed.
3. A discussion of the possible etiology of non-parasitic cysts is given.
4. A brief summary of the numbers and types of cases reported through 1951 is presented.

**ACKNOWLEDGMENT**

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**BIBLIOGRAPHY**

MASSIVE RESECTION OF THE LIVER*

JULIAN K. QUATTLEBAUM, M.D.

SAVANNAH, GEORGIA

The removal of a large portion of the liver is a relatively infrequent surgical procedure. Few surgeons have had much experience with the operation. Keen reported the first case in the United States in 1892, and in 1899 he removed the entire left hepatic lobe for carcinoma. In reporting this case, Keen included a table of 76 liver resection cases from the world's literature. Warvi found a total of 570 resected cases of liver tumor to 1945, but in only 223 of the reports was there a complete description of the operations performed with confirmation of the diagnosis by microscopic examination. Tinker found 59 instances of liver resection performed by members of the American Surgical Association to 1939. He concluded that a busy abdominal surgeon at some time would likely encounter one or more hepatic conditions requiring resection.

Conditions for which the liver has been resected include hemangioma, primary and metastatic carcinoma, gumma, tuberculoma and trauma. The most frequent indications for liver resection are hemangioma and carcinoma. Shumacker considers hemangioma to be the most common large resectable hepatic lesion. Resection of the liver for hemangioma frequently entails unusual difficulties in the control of hemorrhage, and even biopsy has been followed by serious bleeding. Regardless of the danger, Wilson states the tumor was removed surgically in 71 of 84 cases in the literature to 1951. The importance of cutting through normal liver tissue rather than through the vascular tumor was pointed out by Horsley in 1916 and has been repeatedly emphasized since. While excision of the tumor is the procedure of choice when it can be safely accomplished, hemangiomas of the liver which are inoperable may be treated with roentgen rays.

Primary carcinoma of the liver is rare but should be considered in the differential diagnosis of any patient with an irregularly enlarged liver and without evidence of malignant disease elsewhere in the body. Few surgeons are optimistic regarding resection of the liver for cancer, the condition being most often incurable when discovered. Hoyne and Kernohan found that extra hepatic metastases were present in 67.7 per cent of the cases studied by them. However, the tumor may be late in metastasizing, and the experience of Keen, Yeomans and Wallace has shown the possibility of prolonging life as much as seven years. It is probable that under the more favorable conditions of modern surgery, with radical removal of the growth by total lobectomy, better results can be obtained.

Metastatic carcinoma of the liver is usually considered hopeless. Under certain circumstances, however, a direct attack upon the hepatic lesion may result in prolongation of life; this is especially true when the hepatic lesion is represented by a solitary metastasis. Wangensteen pointed out that such a tumor may represent only a single embolic venous spread, and he reported three cases in which secondary excision of

hepatic metastases had been performed. Cattell\(^4\) successfully resected a large and apparently solitary metastasis to the right lobe of the liver. Stone\(^7\) did an extensive resection of the right lobe of the liver for secondary carcinoma eight months following a partial colectomy for adenocarcinoma of the ascending colon. The patient did well for six months postoperatively, then developed a recurrence and died. Brunschwig\(^5\) also reported the removal of hepatic metastases at the time the primary growth was resected in several patients, and Thorek\(^20\) successfully removed the greater portion of the left hepatic lobe as part of an operation that included resecting the splenic flexure of the colon for adenocarcinoma.

There is ample evidence that the liver has such a large reserve capacity that a great portion of it may be destroyed or removed before its function is impaired. The studies of Ponfick,\(^23\) von Meister\(^9\) and Fishback\(^8\) revealed that almost complete regeneration of the liver took place within five or six weeks, even when large segments were excised. This experimental evidence has been confirmed by many clinical observations and has eliminated the fear of subsequent failure of liver function after massive resection.

The control of hemorrhage is the most important problem in liver resection. Turner\(^31\) summarizes the methods of hemostasis under the following heads: (a) compression of the vessels in the free border of the lesser omentum; (b) manual pressure on the liver substance at the edge of the wound; (c) clamping across the liver; (d) use of an elastic tourniquet; (e) use of the cautery. Electrosurgical cutting of the liver has been employed by some surgeons\(^10, 16\) in an attempt to reduce the bleeding from the liver surface. The excellent hemostatic properties of the gelatin sponge demonstrated by Jenkins and Janda\(^13\) in experimental liver resection suggest the use of this material clinically, and it has been employed successfully to cover the raw surface of the liver after resection by Altman,\(^1\) Donovan and Santulli\(^9\) and Colbin\(^5\) and no doubt, by many others.

Brunschwig\(^2\) states that although the fear of uncontrollable hemorrhage appears to be the major deterrent for most surgeons operating on the liver, there is ample clinical experience to indicate that the danger from bleeding is far from insurmountable. With adequate blood replacement facilities, extensive resections of the liver may be carried out with reasonable safety.

In massive resections of the liver, Wangensteen\(^35\) temporarily occluded the afferent blood supply to the liver to gain a bloodless field, but the danger of prolonged interruption of the blood flow to the liver in this manner is real, and the experimental studies of Tinker and Tinker\(^5\) and the observations of Raffucci\(^24\) indicate that 15 minutes is the maximum time that pressure may be safely applied to the hepatoduodenal ligament.

Pickrell and Clay\(^22\) employed a technic for relatively bloodless excision of the left hepatic lobe by dividing the liver between two rows of mattress sutures of braided silk in the interlobar surfaces. Langenbuch\(^17\) advocated using this line of cleavage for lobectomy in 1888 with reported less bleeding.

Regardless of the method used, the first consideration in the control of hemorrhage in liver resection is adequate exposure of the lesion. A high left or right paramedian or subcostal incision usually suffices for the average hepatic resection. Tinker\(^30\) suggests dividing the eighth, ninth and tenth ribs near the attachment of the costal cartilages in the removal of large lesions as this will permit upward retracting of from two to four inches.

We have used a generous transverse incision just below the costal margin for large resections of the right lobe. At the junction
MASSIVE RESECTION OF THE LIVER

of the middle and lateral third, this incision
is joined by an oblique incision which di-
vides the costal margin and splits the sev-
enth intercostal space. The right leaf of the
diaphragm is incised as far as necessary.
After dividing the peritoneal reflection from
the right lobe of the liver has been reported
by Brunschwig,2 Stone and Saypol,27 Turner,
Wendel,27 Wright,20 and others.
Because of the increasing interest in
hepatic surgery, the present three cases are
reported. The operations were performed

the liver to the diaphragm, the wound is
opened widely and the right lobe of the
liver can be lifted out of the incision, held
firmly and resected. Most excellent exposure
of the liver is obtained by this type of
thoracoabdominal incision.

Nearly all the reports of massive resec-
tion of the liver concern the left lobe, and
total removal of this lobe has been ac-
complished by a number of surgeons.1, 6, 15, 19, 22

Wangensteen26 successfully removed a
right hepatic lobe which had been com-
pletely replaced by metastatic gastric can-
cer, and the excision of large segment of

for primary carcinoma of the liver, solitary
metastatic carcinoma of the liver and mas-
sive hemangioma occupying the greater
part of the right lobe.

CASE REPORTS

Case 1.—Mrs. D. A. D., white, age 65 years,
was seen February 2, 1952, because of a large and
painful mass located below the right costal margin.
It had been present for at least 6 months. Early in
1951, a persistent discomfort was noticed, and
later the "lump" was discovered, but its presence
was ignored as long as possible. She had lost con-
siderable weight and strength, was suffering con-
stantly with pain in the tumor area and was unable
to do her usual housework.

Fig. 1.—(Case 1). Resection of the right hepatic lobe. The cystic duct, cystic artery, right
branch of the hepatic artery, the right hepatic duct and the right branch of the portal vein
are ligated and divided in the porta hepatis. The liver is incised with the handle of the
knife which exposes the larger vessels without dividing them.
Examination revealed a tall, emaciated woman. A large, firm, nodular tumor could be observed projecting a hand's breadth below the right costal margin, moving with respiration. The tumor was tender and apparently arose from the inferior surface of the liver. There was no jaundice. Physical examination otherwise was normal. Laboratory examinations including roentgenograms of the chest and a gastro-intestinal series were negative. Examination of the blood disclosed the red blood cells to be 4,300,000 per cu. mm.; the white blood count was 7,050; the hemoglobin was 10 Gm. The prothrombin time was normal. Primary carcinoma of the liver was considered the most probable diagnosis, and after adequate preparation, exploration was carried out on February 5, 1952, with intratracheal ether anesthesia.

The abdomen was opened through a right transverse incision directly over the tumor; after exploration, this incision was joined by an incision dividing the right costal margin and splitting the interspace between the eighth and ninth ribs, dividing the diaphragm over the dome of the liver. The tumor was found to occupy almost the entire right lobe of the liver, was pale yellow in color, firm and nodular. Several smaller tumors averaging 2 to 3 cm. in diameter each, were present in the right lobe above the large growth, but no tumor could be located in the left lobe. After dividing the peritoneal attachments of the right lobe, the liver was lifted out of the abdomen and the removal of the entire right lobe together with the gallbladder and caudate lobe was carried out without difficulty.

Removal was begun by ligating and dividing the cystic artery and cystic duct. The right branch of the hepatic artery and the right hepatic duct were ligated and divided. The right branch of the portal vein was isolated, ligated and divided just as it entered the liver substance. With these important structures dealt with, the liver was divided with the handle of the knife as near the falciform and round ligaments as possible. Individual vessels and ducts were clamped, divided and ligated as encountered in the liver substance. No attempt was made to suture the raw surface of the liver. It was covered with a large sheet of gelfoam and the greater omentum which were held firmly in place by 3 large cigarette drains.

Report of the pathological examination of the specimen is as follows:

"The specimen weighs 970 Gm. Sections show the tumor to consist of large and small sheets of tumor cells which show central areas of necrosis, and tendency to duct formation.

Pathological Diagnosis: Primary carcinoma of the liver."

Ten months following operation she is up and about, relieved of the pain and able to do her housework. There is no evidence of recurrence of the tumor, and liver and renal function tests are normal.

Case 2.—Mr. A. H., a white male, aged 67 years, was admitted to the Oglethorpe Sanitarium July 12, 1952, for surgical exploration. For 7 months he had been having attacks of abdominal
Fig. 4—(Case 2). Undifferentiated carcinoma of the body of the pancreas (x43).

Fig. 5—(Case 2). Liver with metastatic carcinoma of the pancreas. Note similarity of tumor to the primary lesion in the pancreas (x43).

Fig. 6—(Case 3). Right lobe of liver with hemangioma and ulcerated portion of stomach.

Pain which were increasing in frequency and duration. In October, 1951, a transurethral prostatic resection for bladder neck obstruction was done. Microscopic examination of the tissue removed disclosed carcinoma and bilateral orchidectomy was then performed. On February 1, 1952, an exploratory laparotomy had revealed a large, firm tumor in the body of the pancreas and a mass the size of a tennis ball in the dome of the right lobe of the liver. Biopsy of the pancreatic tumor was negative for malignancy and the abdomen was closed without anything further being done. The severity of the attacks increased and the pain was uncontrollable. The removal of the lesion in the pancreas, and if possible, from the liver, was advised.

Roentgenologic studies of his chest, gastrointestinal tract and spine were negative; the blood sugar was 88; serum amylase 24 mg. per cent; cephalin flocculation 0; thymol turbidity 1.5 units; and thymol flocculation 0. The hemoglobin was 13 Gm.

Operation was performed on July 15, 1952, with intratracheal ether anesthesia. The abdomen was opened through a high transverse incision which divided the left costal margin. Neither free fluid nor enlarged nodes were seen. The mass occupied almost all of the pancreas and was fixed to the surrounding tissues.

The pancreas was divided at the neck approximately 2 cm. beyond the demonstrable tumor and was removed together with the spleen. The transverse incision was then joined by an oblique incision which split the seventh right intercostal space and costal cartilage and divided the right diaphragm. The liver was mobilized and elevated out of the wound. The greater portion of the right lobe containing the tumor was removed. The omentum was placed around the remains of the lobe and drains were inserted between the liver and the chest wall and in the left subphrenic space. Convalescence was remarkably smooth; and the patient left the hospital on the thirteenth postoperative day, free of pain and in good condition.

Pathological Report. Sections from the tumor mass of the pancreas show that the tumor is very cellular, with fairly solid nests of uniform, small, rounded cells containing a small amount of cytoplasm. In other areas there is a well developed glandular
pattern in which the nuclei show extreme variations with some remarkably large nuclei.

**Diagnosis.** Undifferentiated carcinoma of the pancreas with large solitary metastasis to the liver.

Six months later Mr. H. is relieved of his abdominal symptoms, but has a metastasis in the right humerus.

**Case 3.—Mrs. W. L. M., white, aged 44 years, was hospitalized in April, 1933, because of chills and fever and a large movable tumor in the right upper abdomen. Urological investigation revealed an infected hydronephrosis on this side. A severe and undiagnosed illness in early adult life had left her with a badly crippled heart and ankylosis of the left hip joint.

On April 11, 1933, the right kidney was explored. The hydronephrosis was less marked than expected, and the kidney was found to be displaced by a large mass in the liver. This tumor was found to occupy the greater portion of the right lobe of the liver, projecting from the anterior and inferior surfaces. It was deep purple and mottled in appearance, soft and spongy in consistency and very vascular. The process was confined to the right lobe. A section of the tumor was removed for biopsy, the bleeding being controlled with difficulty. The pathological diagnosis was "Cavernous Hemangioma of the Liver, with secondary subacute hepatitis."

Deep roentgen ray therapy was given to the tumor area at irregular intervals for the next 8 years. Each course of treatment would be followed by prompt reduction in the size of the tumor and improvement in the patient's general condition.

After a time, the tumor would enlarge and the symptoms return.

In 1941, Mrs. M.'s course was one of progressive deterioration. The pain and soreness in the upper abdomen was constant; loss of weight and strength was continuous.

On January 5, 1942, she was operated upon. The tumor was found to be smaller and less vascular, and the surrounding liver tissue was firm and fibrous. The left lobe of the liver was normal.

Exploration also revealed 3 ulcers in the pyloric portion of the stomach. The ulcers had not been demonstrable in gastro-intestinal studies in 1940, but they probably explained the increasing pain in the past year.

Better exposure was obtained by dividing the right costal margin which permitted the liver to be lifted out of the wound. Practically the entire right lobe containing the tumor and the gallbladder were easily removed in a large wedge-shaped mass. The stomach was resected and a posterior Polya anastomosis done. Pathological examination disclosed no evidence of malignancy in the gastric ulcers, and sections from the tumor in the liver show coarse fibrous trabeculi surrounding blood-filled spaces. There are no remnants of liver cells and no tumor cells. The pathologist noted that a section of the large vascular growth of this liver was examined in 1933, and a diagnosis of Cavernous Hemangioma was made at that time.

Mrs. M. remained well for 2 years. In March, 1944, she noticed the appearance of jaundice, and in June, 1944, she was again operated upon, and a large, firm mass in the head of the pancreas ob-
structing the common bile duct was sidetracked by anastomosing the duct to the jejunum. There was no regeneration of the right lobe of the liver and no evidence of the hemangioma. The left hepatic lobe was considerably enlarged and rounded. Mrs. M. recovered from this operation, lived 13 months and died of congestive heart failure. There had been no return of jaundice. No autopsy was performed.

COMMENT

Resection of the liver is rather infrequently performed and total lobectomy has usually been confined to the left lobe. Complete removal of the right and caudate lobes with gallbladder attached, was successfully accomplished in one of our cases and apparently represents the rare occasion where these lobes are removed. Primary carcinoma confined to either lobe may be treated by wide excision or preferably by lobectomy. Early exploration is essential, as Lemmer has shown the average duration of symptoms of primary carcinoma of the liver is seven months from their onset to the death of the patient. The advisability of removing solitary metastatic carcinoma in the liver either at the time of the primary procedure or as a "second look" undertaking is debatable, and certainly should be limited to selected cases. However, there is little to lose by the effort. The removal of metastatic cancer appears justifiable since there is some chance of success, and failure to remove the lesion results in death.

It is admittedly difficult to detect metastases deep in the liver, and the impossibility of being certain that no other metastases are present is granted. However, if resection of the involved liver is possible, the patient is probably better off with this focus of malignancy removed.

Hemangioma is the most common resectable liver tumor, and it also occurs in the liver more frequently than in any other organ of the body. Although often small and symptomless, this lesion may become quite large. These vascular tumors are frequently difficult to remove, and the preliminary use of roentgenotherapy may reduce the size of the tumor considerably and as in the case reported, make ultimate removal less formidable.

Adequate exposure of the lesion is necessary for the safe removal of any large liver tumor. Much of the difficulty in controlling bleeding from the liver can be avoided by making the growth accessible. For large resections, the transverse thoraco-abdominal incision described makes possible the complete mobilization of the liver and enables the surgeon to lift this organ out of the wound where it can be more readily dealt with. Our limited experience with liver resection leads us to believe that the more complicated methods of controlling hemorrhage by tourniquet, mass sutures and artificial compression of the liver substance are unnecessary. In our cases, the liver was divided with the handle of the knife which exposed the larger vessels and ducts without cutting them. They were then divided between clamps which were tied off, as encountered. In this manner, the difficulty of securing and ligating vessels which retract within the liver substance when divided by sharp dissection, is avoided. No attempt to approximate liver surfaces with sutures was made. It is realized that this method may well be inadequate in dealing with a very vascular tumor, but it is still applicable, provided the resection is carried out through normal liver substance. Garre states that "no method can be introduced into general surgery unless it can be executed with simple means which every operator has at hand." This method of exposing and resecting the right lobe of the liver at least has the merit of simplicity.

SUMMARY

Three cases of massive resection of the liver are reported. Total lobectomy is advo-
cated for primary carcinoma of the liver confined to one lobe. Solitary liver metastasis should be removed at the time of the eradication of the primary lesion or as a “second look” procedure in selected cases. Early exploration for suspected cancer of the liver is imperative. With adequate exposure and mobilization, resection of the liver can be accomplished with reasonable safety, provided blood replacement facilities are available.

BIBLIOGRAPHY

34 Wangensteen, O. H.: Primary Resection of Rectal Ampulla for Malignancy with Preserva-


Discussion.—Dr. Howard A. Patterson, New York, N. Y.: Dr. Quattlebaum is not only very able but very bold, and that is a good combination for this sort of problem. I hesitate to discuss his paper for I have done only one resection of the liver that could be called a "large" resection. I had never even seen one until a very favorable case appeared and I am afraid we will not often have such a favorable one.

This patient was a lady of 44 who had a small spindle-cell sarcoma removed from the right thigh nearly seven years before. She had noted for some months a gradually increasing mass in the upper abdomen and her only complaint was that she got very hungry but did not have room to eat. As soon as she would eat she would be very uncomfortable. This about half of which was in the right lobe and about half protruding out of it, and it had the gallbladder spread out over its lower pole. It weighed approximately 800 Gm. after removal and was of exactly the same histology as the small tumor that had been removed six and a half years before from the thigh. We tried to control the bleeding very much as Dr. Quattlebaum did and were not quite so successful. We were able to ligate most of the major bile ducts and vessels encountered; there was no severe bleeding but there was a constant slow ooze from all surfaces. There was a large cavity in the lobe, resembling what I imagine a horse bite would look like if a horse took a bite out of the liver. We tried various methods of bringing the superior margin of the defect down toward the inferior margin, and vice versa, without much success. Finally we ended by using a method of suture which was reached by a trial and error method, and which was very satisfactory. We took some ribbon catgut which was quite soft and quite strong, and put mattress sutures in about one inch back from the cut edges, drawing the superior margin down to the inferior margin, and could pull these two almost together without having the rather thin soft capsule, which seemed unusually thin to us, tear. Then we put a strip of gelfoam along the raw edge, anchored in place by fine chronic sutures which were anchored into the ribbon gut rather than into the liver capsule, because the liver capsule would not hold them at all. The ribbon gut held them very well so that the gelfoam could be kept in place. It has been eight months since operation and she seems quite well. Of course rather liberal drainage was established and she drained some material for about three weeks, although there was very little after the first few days.

I would like to thank Dr. Quattlebaum for the privilege of discussing his paper.

Dr. Robert J. Coffey, Washington, D. C.: Dr. Quattlebaum's presentation brings up some very intriguing considerations, not only in the treatment of primary tumors of the liver, but in the surgical attack on metastatic deposits in this organ. So often one finds a primary carcinoma of the colon which is locally operable with limited or no glandular involvement, only to be frustrated by palpating a solitary or localized metastasis in one or the other lobe of the liver. As I see it, the problem of resection of these hepatic metastases depends on two considerations. In the first place, do these represent the sum total of the neoplastic deposits in the liver or are they merely the palpable manifestations of widespread showering of the liver with metastatic emboli? More investigation of this question is certainly warranted. In the second place, the problem concerns the amount of the liver that may be tolerably resected. In support of Dr. Quattlebaum's thesis that a major portion of the liver may be successfully resected, I should like to report a single case.

On April 4, 1951, I operated on this 38-year-old female because of a large upper abdominal mass. This proved to be a solitary tumor occupying the entire left lobe of the liver, the right lobe being completely uninvolved. The left lobe
of the liver was resected and the tumor was reported by Dr. Geschickter as being a benign hepatoma. Except for a transient hypoproteinemia, postoperative evaluation of her hepatic function by a variety of tests revealed no abnormality. On November 7, 1952, the patient was readmitted to Georgetown University Hospital complaining of upper abdominal pain. A mass was palpable in the right hypochondrium. Inasmuch as a review of the histologic slides reaffirmed the diagnosis of benign hepatoma, she was again operated upon. The medial half of the right lobe of the liver was occupied by a multinodular tumor. Since the lateral part of the right lobe was apparently tumor-free, the involved medial half of the right lobe was resected without serious technical difficulty. The gallbladder was preserved. Histologically this tissue was identical to that of the original tumor in the left lobe. Her postoperative convalescence was uncomplicated and she was discharged from the hospital on December 2, 1952. A battery of postoperative liver function tests revealed no abnormality. In summary, this patient tolerated removal of approximately 70 per cent of her liver (Fig. 1) without serious hepatic dysfunction.

Dr. Grant E. Ward, Baltimore, Md.: I should like to call attention to some experimental work that Herman Pearse and I did about 20 years ago in an effort to determine what could be done in the resection of parenchymatous organs by electrosurgery. We experimented on dogs, and found that large sections of the kidney, spleen and liver could be resected with electrosurgery, but a considerable mass of coagulated tissue was left behind which took a long time to heal. We did not have any serious postoperative hemorrhages.

I want to congratulate Dr. Quattlebaum on his work. I think his technic is probably better than the use of the electric current because it does not destroy so much tissue.
Obstruction to the free flow of bile through the lower end of the common duct due to lesions of the ampulla, the papilla of Vater and the sphincter of Oddi occurs in a sufficient number of patients to make this a problem of real clinical importance. This obstruction can occur with or without pathologic conditions elsewhere in the extrahepatic biliary tract, but is usually encountered in patients with gallstones. This intermittent or persistent obstruction is responsible for an appreciable number of the unsatisfactory results following cholecystectomy for cholelithiasis. It is the purpose of this paper to discuss only one group of these failures after operations on the biliary tract. The discussion will be confined to those patients who were found to have fibrosis of the sphincter of Oddi, or those with stricture of the papilla of Vater. This limitation is done in the interest of clarity, since a discussion of obstruction of the various structures at the lower end of the entrance of the biliary tract into the duodenum raises many complicated problems, including the treatment of benign and malignant tumors as well as pancreatitis. This problem is presented from the standpoint of the findings that may be encountered more commonly in primary or secondary operations upon the biliary tract. Most of the experiences which will be reported deal with secondary operations in our own cases as well as those referred to us for treatment following cholecystectomy and choledochostomy. From this experience, we believe it is possible to reduce the number of secondary operations if the possibility of fibrosis is considered sufficiently at the initial operative procedure, and we wish to point out the frequency with which this condition is encountered, as well as the means of its recognition at the initial procedure.

In several communications from this clinic, the indications and incidence of common duct exploration in patients having surgical procedures on the gallbladder have been presented. For the purposes of this discussion it is sufficient to state from these previous reports that slightly less than half of all patients operated on here for cholelithiasis have exploration of the common bile duct, and approximately 20 per cent of all patients are found to have stones in the common bile duct. In addition, this high rate of exploration of the common duct has led to the discovery of an appreciable number of obstructions at the ampulla of Vater, many of which had not been suspected preoperatively. This is obviously the time to discover them and not at some subsequent operation made necessary by the recurrence or persistence of symptoms. The indications for exploration of the common duct are not part of this paper, but we would re-emphasize that frequent exploration will be necessary if benign obstructions of the ampulla are not to be missed.

HISTORY

In 1901, Opie demonstrated that obstruction at the lower end of the common bile duct by stone could produce acute pancreatitis. Archibald, in 1913 and again in 1919, drew attention to the role of spasm of the sphincter of Oddi produced by mechanical or chemical stimuli and related production of this finding to the pancreatitis. He reported eight patients treated by transduodenal sphincterotomy. Berg, as early as 1922, suggested that biliary stasis might be the result of a functioning disorder of the sphincter of Oddi and was able to demonstrate hypertrophy of this muscle in an individual who had biliary obstruction without other findings in the biliary tract. In many reports in the literature dealing with surgery of the biliary tract, particularly in those concerned with postoperative results, mention has been made of spasm, narrowing and fibrosis of the sphincter as a cause of persisting symptoms, but few reports have had more than a cursory interest in this problem. McGowan, Butsch and Walters, in 1936, demonstrated that the pressure in the common bile duct recorded through an implanted T tube following cholecystectomy could be raised by administration of morphine sulfate as high as 160 mm. of water. They showed that each rise of intraductal pressure was associated with an attack of pain similar to that experienced by the patient previous to cholecystectomy.

Branch, Bailey and Zollinger, in an experimental study on dogs to determine the effect of forcible dilatation of the papilla of Vater, found that a certain amount of scarring occurs in the region of the ampulla after extensive dilatation. This was moderate to marked in one-half of the dogs. The resulting dilatation of the hepatic ducts following this dilatation was lessened if the common bile duct was drained. Furthermore, they found that the dilatation produced did not result in permanent enlarge-
269 cases after cholecystectomy and found it necessary to re-explore 20 for persistent pain, and stricture of the ampulla was found in two of these. Colp in a discussion of this problem believed that if patients continue to have pain following cholecystectomy, and exploration of the upper abdomen and common bile duct was negative, symptoms probably were due to interference with the sphincteric mechanism, caused by hypertrophy, stenosis or inflammation of the papilla of Vater. He suggested that cholecdochoduodenostomy be done for organic stenosis, but that a division of the sphincter be done for spasm; he reported eight cases so treated and followed for two to eight years, with six having obtained satisfactory relief.

Doubilet and Mulholland, in two reports, related obstruction of the sphincter and lower end of the common duct to spasm; they showed this could result in the development of pancreatitis, and recommended sphincterotomy. They were less concerned with the influence of the sphincter on the function and production of symptoms in the biliary tract. They showed that dogs sacrificed at the end of two years after sphincterotomy still had an incompetent sphincter. Mahorner, in a paper before this Association in 1949, reported 16 cases of obstruction of the lower end of the common duct, caused by stones in 11 cases and stenosis of the ampulla in four, which was demonstrated only by transduodenal exploration. In two instances he noted that dilators passed from above had made a false opening in the mucosa of the duodenum. He recommended duodenotomy in any patient in whom the patency of the ampulla could not be demonstrated from exploration of the common duct. Trommald and Seabrook reported eight patients in whom they demonstrated obstruction at the ampulla due to fibrosis that was relieved by sphincterotomy. Cole and Grove recently reported two patients with stenosis of the sphincter treated by sphincterotomy with satisfactory results.

**ETIOLOGY**

The pathogenesis of fibrosis of the sphincter of Oddi and papilla of Vater is not fully understood. Unquestionably, long-standing spasm from any cause may be an important factor in its development. It may be similar to the development of fibrosis of the anal sphincter, which does result from long-standing spasm and abnormal function. Infection in the biliary tract and of the mucosa of the duodenum, as well as in the head of the pancreas, may be responsible. The frequent association of stone in the common duct with this finding indicates that irritation and associated infection and spasm of the muscle may lead to fibrosis. This is not true of all cases associated with stones, since pre-existing spasm or obstruction in this region may lead to reformation of stones in the common duct. In the latter group the fibrosis is responsible for the formation of stones, rather than the reverse. During an operative exploration it is frequently impossible to determine whether one is dealing with spasm or fibrosis. In those cases in which sphincterotomy is done, however, a definite, hard, fibrous area or a fibrous band in which muscle fibers may be determined by biopsy, can definitely be shown.
dentation of the anterior wall of the duodenum may even be observed, without actual passage of the probe through the papilla. Under these circumstances, if any doubt exists, it is best to visualize the papilla by opening the duodenum by a longitudinal incision. Inability to get through the ampulla and papilla may be due to any one of a number of conditions, as shown in Table I. The first five of these are pertinent to this discussion.

The role of the sphincteric mechanism in the production of pancreatitis and the surgical treatment of such cases have been fully reported by Doubilet and Mulholland. Cattell and Warren\textsuperscript{14} have recently reported the choice of therapeutic procedures in the treatment of chronic relapsing pancreatitis, including sphincterotomy for this condition. Premalignant lesions of the papilla causing obstruction in the ampulla were likewise reported from this clinic.\textsuperscript{10} In an earlier paper before this Association we reported on our experience in the treatment of malignant lesions of the periampullary area, and evaluated the results.\textsuperscript{8} These three causes of obstruction to the common bile duct will be excluded from this paper.

**SURGICAL APPROACH**

Different methods are available as aids to the discovery of obstruction to the lower end of the common duct: (1) manometric pressure studies, (2) cholangiography, (3) operative exploration of the common bile duct and (4) transduodenal exploration. Manometric studies have been extensively used by Mallet-Guy and others who have utilized them to direct the operative procedure. We have not employed this method. Similarly, cholangiography has had wide use and was recently reported by Mixter.\textsuperscript{26} This has been used in a limited number of our cases as we have depended chiefly upon mechanical means of exploration of the common bile duct.

At the time of common duct exploration, if a probe cannot be passed through the sphincter of Oddi, the cause of this obstruction must be demonstrated. The incision in the common bile duct must be large enough to permit the passage of instruments. The duodenum and head of the pancreas should be freed and elevated to change the direction of the common bile duct. This frequently leads to the successful passage of a probe and avoids the accumulation at the lower end of the common duct as well as the uneven course of the common duct through the pancreas. At times, a fine probe may be passed through, but difficulty will be experienced in passing graduated dilators. If a 3 mm. dilator cannot be passed easily through the ampulla, probably fibrosis of the sphincter or stricture of the papilla is present. Under these circumstances a transduodenal exploration should be carried out, permitting exploration from each end.

With the demonstration of this form of obstruction, one of two types of correction can be employed, depending upon the degree and extent of the obstruction. The majority can be relieved by forcible dilatation from above by means of graduated dilators. Under these circumstances, with avulsion and dilatation of the muscle fibers, the patency should be maintained by means of an indwelling tube and we employ the long T tube, passing it through the ampulla into the duodenum routinely. The second method of correction consists of division of the mucosa of the papilla and division of the sphincter muscle through the transduodenal approach. This may be accomplished by the sphincterotome through the common duct, but if this is used, it should be done under direct vision. The use of the Lahey grooved catheter, recently reported,\textsuperscript{22} is quite effective. The method of treatment employed in the cases to be reported was direct incision of the sphincter, with or without suture of the mucosa. In all of our
sphincterotomies, we have used the long T tube.

Following common duct exploration in which no obstruction is demonstrable at the ampulla, a short-armed T tube is placed in the common duct and removed in from eight to 12 days. If definite fibrosis or stricture is present and the obstruction is overcome by forcible dilatation and avulsion of the fibers, a long T tube is always used and left in place for a minimum of six months. In many patients it has been left for at least a year. During this time the T tube is irrigated twice daily with normal saline solution and a cholangiograph given for the entire period that the tube is left in place. When the long T tube is implanted at the time of sphincterotomy, it is left in usually for a shorter period of time of from two to six months, depending on the size of the common duct and intraductal findings.

Doubilet and Mulholland, in their sphincterotomies for pancreatitis, believe that a tube through the ampulla is unnecessary, even for the immediate postoperative period. In our own experience, we have not encountered any increase in complications as a result of the tube implantation, but in many cases, the lumen of the tube does become encrusted with sediment in time in spite of any precautions. The use of the indwelling T tube is the best assurance of maintaining patency of the sphincter and papilla, and the need for it is suggested by the experimental work of Zollinger. Forcible dilatation of the ampulla and sphincterotomy are followed by submucosal hemorrhage, edema, fibroblastic proliferation and later fibrosis. Theoretically, the tube must be left until absorption of the scar has occurred and smooth mucosa healing has resulted.

**CLINICAL DATA**

For the purpose of this report we have taken a selected group of patients with fibrosis of the sphincter or stricture of the papilla, operated on for this condition over a period of 15 years. Only those cases have been selected where no doubt existed as to the presence of a localized narrowing at the sphincter level or at the papilla. We have not included patients with pancreatitis. After a careful study of the histories of a much larger group in whom the possibility of fibrosis was considered either preoperatively or at the time of operation, we have selected 49 cases in which there could be no question of the finding of fibrosis. Those cases in which the diagnosis was not substantiated, was indefinite or was questioned by the operating surgeon, were excluded. A satisfactory result was to be expected in these doubtful cases and it was believed that their inclusion would put too favorable a light on the problem. Because of our interest in this problem over many years, the diagnosis is frequently considered, particularly in those patients who have recurrent symptoms after gallbladder surgery.

Of the 49 cases, 14 were males and 35 females, which is the usual sex incidence of cholelithiasis. The age of the patients ranged from 29 to 73 years, but 31 patients, or approximately two-thirds, were between the ages of 30 and 50.

The symptoms encountered in this selected group of cases included all of those commonly associated with calculi in the biliary tract. The most conspicuous clinical feature was the occurrence of intermittent attacks of severe, right upper quadrant or upper abdominal pain, with the typical radiation to the back and to the shoulder. These attacks were frequently associated with anorexia, nausea and vomiting. Forty-two of the 49 patients complained of these typical attacks which usually required a hypodermic injection for relief. Characteristically, these attacks had been present for a long period of time.

Twenty-seven patients gave a history of intermittent or persisting jaundice following
their attacks of abdominal pain. Seven patients gave a history of chills and fever. Appreciable weight loss was a prominent finding.

Thirty-two patients had had previous cholecystectomy without relief of symptoms and in several instances the frequency and the severity of the attacks were not modified by the previous operation. Several patients had had choledochostomy performed at the time of cholecystectomy, and in six of these a common duct stone had been removed previously, yet this did not result in relief of pain. In some of the patients who had choledochostomy, a normal cholangiogram had been demonstrated postoperatively.

Of the 32 patients who had had previous surgical procedures on the biliary tract, common duct stones were present in 13 at the time fibrosis was discovered. In six of these, as mentioned above, one or more common duct stones had previously been removed. It is impossible to determine in these 13 cases whether they were retained common duct stones or they had formed as a result of the obstruction.

Seventeen patients had moderate to marked dilatation of the common duct. It is recognized that common duct dilatation is a frequent finding following cholecystectomy, and since 32 patients had had this operation performed, it may have been a factor in the production of dilatation. The fact that only 17 patients had had an appreciable common duct dilatation out of 49 in whom fibrosis was demonstrated illustrates clearly that this finding can be present in the absence of common duct dilatation and in the absence of jaundice. In the entire group, other pathology of the biliary tract was encountered that may have at least partially been responsible for the symptoms. Two patients were found to have impacted cystic duct stones. Two patients had partial strictures of the common duct in addition to fibrosis of the sphincter. One had an aber-
rant vessel across the termination of the common duct and duodenum, and severe ulcerative colitis was present in one.

With the demonstration of fibrosis of the sphincter, the operative procedures carried out in these 49 cases were as follows: formidable dilatation of the sphincter was performed in 35 patients, and in these a long T tube was inserted. Transduodenal sphincterotomy was performed in ten, and in each of these the long T tube was utilized. Dilatation of the sphincter with implantation of a short T tube was carried out in three patients. These three procedures were performed previous to the introduction of the long T tube, and it is of interest to note that one was a failure and two patients had only partial relief. In the final patient, choledochoduodenostomy was performed since previous subtotal gastrectomy had been carried out. There was no operative mortality in this group. Only two subsequent deaths have occurred, one a year later from chronic relapsing pancreatitis and pancreatolithiasis and a second death from carcinoma of the common duct.

Seventeen patients have been followed from three to 12 years and 13 of these were completely relieved of symptoms. Two had been improved but experienced occasional mild attacks; one was a failure. One patient died of carcinoma of the common duct, determined by subsequent exploration.

Twelve cases were followed from one to three years; ten patients were relieved and two were improved. Eight cases were followed for six months to one year with five patients being relieved, two improved and one patient died as the result of chronic relapsing pancreatitis. Ten cases were followed for less than six months and in two, no follow-up data were available. Of the 37 cases followed for six months or more, 28 patients had complete relief of symptoms, six were improved, one was a failure and two were dead.
CASE REPORTS

Case 1.—A 66-year-old man had a short history of upper abdominal symptoms, followed by jaundice. Cholecystograms showed the presence of gallstones and in March, 1939, cholecystectomy were performed, with removal of his gallbladder and common duct stones. He was relieved of symptoms for a short time, following which he had attacks of pain with chills and fever. He was operated on in June, 1939, at which time a choledochostomy was done and a common duct stone removed. Shortly afterward jaundice again recurred, with chills and fever, and he was admitted to the clinic in December, 1940. At this third operation common duct stones were found with marked dilatation of the common duct, and a marked fibrosis of the sphincter of Oddi was demonstrated. A transduodenal sphincterotomy was performed and a long T tube was inserted. He was completely relieved of symptoms; the T tube was left in place for 27 months and was removed in March, 1942. He has remained well for 10½ years since the last operative procedure.

Comment. This patient had two previous operations, with removal of stones from the common duct. A third operation was required because of an unrecognized fibrosis of the sphincter of Oddi.

Case 2.—A 48-year-old nun was first seen in the clinic in August, 1940, with a history of having had cholecystectomy 10 years previously. She complained of intermittent attacks of right upper quadrant pain, extending to her back, with jaundice following each attack of pain, which was associated with anorexia, nausea and vomiting. The serum bilirubin was 0.8 mg. per 100 cc.; biliary drainage was negative for stones. She was operated on in May, 1941. The common duct was found to be dilated but no stones were present. A stricture of the papilla of Vater was found and dilated, following which a T tube was inserted and was removed 2½ months after operation. She has been completely relieved of symptoms.

Comment. This patient had persisting attacks of pain following cholecystectomy. On exploration, the common duct was dilated; no stones were present. There was a stricture of the papilla and symptoms were relieved by dilatation.

Case 3.—A 48-year-old woman was first seen in February, 1948, because of attacks of right upper quadrant pain intermittently for 20 years. Eight years previously a cholecystectomy had been done for gallstones. Since cholecystectomy, for the 8 year period, she had had the same type of attacks as prior to the removal of her gallbladder; these attacks occurred 3 to 8 months apart, without warning. After full studies, all of which were normal, a diagnosis was made of common duct stones.

Operation was performed in March, 1948. A dilated cystic duct stump was found; the common duct was dilated to twice normal size and a soft stone was removed from the ampulla. The ampulla was dilated up to a number 7 Bakes dilator after removal of the stone, and a short T tube was inserted. A cholangiogram done on the eleventh postoperative day showed the normal passage of the radiopaque material into the duodenum and no evidence of retained stones. The T tube was removed on the twelfth day, and following its removal she had a severe attack of pain. Relief was obtained with nitroglycerine and demerol.

Following her discharge from the hospital the patient had almost daily pain with no interval of freedom longer than 3 days. She was readmitted to the hospital in 8 weeks and a diagnosis made of fibrosis of the ampulla of Vater. Operation was performed May 6. On exploration of the common duct, a saccular dilatation immediately proximal to the ampulla of Vater was found, from which debris was removed. Since it was not possible definitely to demonstrate a probe passing through the papilla, duodenotomy was performed and a fine probe inserted in a retrograde direction, demonstrating fibrosis of the sphincter. The sphincter was first dilated and then incised and a long T tube inserted.

The patient made a good recovery from operation. The T tube was removed 9 months later and she has had no attacks of pain or other symptoms in the 4½ year period since operation.

Comment. This patient at a second operation had removal of common duct stone and dilatation of the sphincter with the insertion of a short T tube. Recurrence of symptoms required sphincterotomy.

Case 4.—A 83-year-old physician was first seen in July, 1944, stating that since 1939 he had had intermittent attacks of gallbladder colic. Gallstones were demonstrated, and in June, 1943, a cholecystectomy and choledochostomy had been performed. The T tube was left in the duct for 10 days and when a cholangiogram was done prior to its removal, it reproduced his previous attacks of pain. Since operation he had had intermittent attacks of colic similar to those prior to cholecystectomy. After study, a preoperative diagnosis was
made of recurrent common duct stones and spasm of the sphincter of Oddi.

Operation was performed in July, 1944, and on exploration of the common duct, no stones were found. A probe could not be inserted through the ampulla. Transduodenal exploration was done and the ampulla identified by the injection of saline solution through the common duct. Sphincterotomy was then carried out, suturing the edges of the mucosa, following which a long T tube was inserted through the ampulla. The T tube was left in place for one year. This patient has had complete relief of symptoms for 8 years.

Comment. This physician had recurrence or persistence of pain after cholecystectomy and choledochostomy. Pain was reproduced by cholangiography. Symptoms were due to fibrosis of the sphincter, with other pathology.

Case 5.—A 53-year-old woman was first seen at the clinic in August, 1948, with a 28-year history of attacks of epigastric pain, worse after the ingestion of fat. Two years previously, cholecystectomy and choledochostomy had been performed; stones were removed with the gallbladder and from the common duct. Eight months previous to admission, painless jaundice had developed, fluctuating in intensity, with severe pruritus. She gave a history of having drained bile from her wound for one year following the cholecystectomy.

Liver function tests showed a severe degree of hepatic damage. The serum bilirubin was 4.1 mg. per 100 cc.

On August 11, 1948, operation was carried out. The common duct was dilated to 2 cm. in diameter, but a probe could not be passed through the ampulla. Because of the patient's poor condition and bad liver function, the operation was terminated after choledochostomy and short T tube drainage was carried out during his hospital admission. Following operation, jaundice disappeared but his urine remained dark and the stools light and subsequently itching with jaundice developed, which persisted. Liver function tests were negative; the serum bilirubin was 1.5 mg. per 100 cc.; the bromsulphalein retention was 40 per cent. He was re-operated upon on September 17, 1947, and cirrhosis of the liver and portal hypertension were demonstrated. The common duct was not dilated but contained considerable debris. No definite stones were present. The ampulla was contracted but was dilated up to a number 8 dilator and a long T tube was passed through the ampulla. His condition improved and 3 months later the T tube was removed. In March, 1948, 6 months after operation, his symptoms returned and he also noted intermittent chills and fever. The bilirubin was found to be 3 mg. per 100 cc. He was considered to have a recurrence of fibrosis of the ampulla of Vater because of too short a period of drainage, and was advised to return for sphincterotomy. This has not been performed.

Comment. An unsatisfactory result in this case was due to inadequate treatment of fibrosis and an insufficient period of drainage.

SUMMARY

Fibrosis of the sphincter of Oddi may be responsible for some of the symptoms in patients with cholelithiasis. It can best be demonstrated during exploration of the common duct. It may be overlooked unless broad indications for choledochostomy are used.

Unrecognized fibrosis of the sphincter or stricture of the papilla may be responsible for recurrence or persistence of symptoms.
FIBROSIS OF THE SPHINCTER OF ODDI

following cholecystectomy and may lead to the necessity of a secondary operation. Repeated operations for common duct stones are frequently required because of fibrosis of the sphincter. Fibrosis of the sphincter should be suspected when difficulty is experienced in probing the lower end of the common duct. Inability to get the probe through the ampulla may be due to a number of reasons, one of which is this lesion. Fibrosis can be relieved by forcible dilatation or by transduodenal sphincterotomy. The patency of the ampulla should be maintained by the insertion of a long T tube which is passed into the duodenum and kept in place for several months.

An analysis of 49 cases of fibrosis of the sphincter of Oddi or stricture of the papilla of Vater is presented. Complete relief of symptoms was obtained in 90 per cent. Illustrative case histories are briefly reported.

TABLE I.—Causes of Obstruction at the Ampulla of Vater.

1. Common duct stone.
2. Stricture of papilla of Vater.
3. Saccular dilatation of terminal common duct.
4. Deviation of common duct through pancreas.
5. Fibrosis of sphincter of Oddi.
6. Pancreatitis.
7. Penetrating duodenal ulcer.
8. Papilloma of papilla of Vater.
9. Carcinoma of periampullary area.

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BENIGN TUMORS OF THE COMMON BILE DUCTS

The literature contains reports of only two types of benign tumors of the common bile ducts: the idiopathic intraductal papillary-mucinous tumor and the lesion described by Halban and associates as an intraductal papillary adenocarcinoma in situ. These lesions appear to be rare and the majority of reports in the literature have been case reports.

It is noteworthy that both of these benign tumors have been reported in association with adenocarcinomas of the distal common bile duct. This raises the possibility that a new category of benign tumors of the common bile ducts might be described.
BENIGN NEOPLASMS OF THE EXTRAHEPATIC BILE DUCTS

Case Report of Cyst Causing Obstruction

RUSSELL O. LYPAY, M.D.
GREENSBORO, N. C.

BENIGN NEOPLASMS of the extrahepatic ducts are seldom encountered by surgeons. The literature during the past 25 years contains numerous case reports of so-called idiopathic dilatation, several reports of malignant growths involving the ducts, but only an occasional reference to a benign tumor of these structures. Cysts with no apparent communication with the lumina of the ducts are rare. The rarity of benign tumors of the extrahepatic ducts as a cause of intermittent jaundice stimulated my interest in these lesions.

The relative infrequency of benign, as compared with malignant, tumors of the ducts is well illustrated by the report of Marshall, who reviewed all cases observed at the Mayo Clinic from 1910 to 1930. In approximately 20,000 operations on the biliary tract in that clinic he found 45 cases of malignant tumors of the extrahepatic ducts, but only four cases of benign tumors. The type and location of the benign tumors was as follows: adenofibroma of the stump of the cystic duct following cholecystectomy, 2; papilloma of the cystic duct, 1; congenital or idiopathic cyst of the common duct, 1.

In 1933 Christopher collected 41 cases of benign tumors of the extrahepatic ducts. To this number he added a case of adenoma of the ampulla of Vater. Leriche reported a massive papillomatous tumor of the choledochus weighing 750 Gm. Several other cases with papillomas were reported from 1940 to 1947.

Walters successfully removed a neuroma of the cystic and common ducts in a woman who had previously undergone a cholecystectomy. She gave a history of intermittent jaundice with a severe attack being present for two and a half weeks at the time of operation.

In 1946 Rogers reported a case of papillary cystadenoma of the common hepatic duct in a woman 41 years of age. He reviewed the English literature from 1920 to 1946 and found references to 19 cases of benign tumors of the extrahepatic ducts. In his patient a small papilloma was found arising from the common hepatic duct and prolapsed into the common duct. It was removed and its base cauterized. The pathological report was papillary cystadenoma of the bile duct. His patient remained well for almost a year, then developed biliary obstruction from which she died. Post-mortem examination showed a papilloma of the hepatic duct with abscesses of the liver, etc.

Chu, who reviewed the world literature up to 1950, found references to 54 cases of benign tumors of the extrahepatic ducts. Because of a lack of satisfactory histories and histological confirmation, he selected only 30 as proven cases. To this number he added a case of his own.

Of these 30 cases selected by Chu, 18 were females and nine were males. There was no mention of the sex in three cases.
Their ages ranged from 40 to 76 years. None of them were diagnosed preoperatively or antemortem. In 11 of these patients the tumors were successfully removed.

Chu recorded the type and frequency of the 55 benign tumors as follows: papilloma and polyp, 24; adenoma, 18; fibroma, three; neuroma, three; lipoma, three; granuloma, two; melanoma, one; and carcinoid, one.

There was no history of recent fever or respiratory infection. Since she had been living alone, her diet was inadequate.

Thirteen years prior to this admission she had received bismuth and arsenic treatments for a positive serology which, from re-evaluation at this time, could have been a false positive. The family history was negative except for her statement that one sister died of liver trouble.

In December, 1950, the patient had an attack of jaundice which lasted about two weeks. This episode was characterized by a painless type of jaundice, malaise and possibly a low-grade fever. After a 6-months' interval of apparently normal health and freedom from jaundice she again became icteric.

Physical examination showed a well nourished woman whose skin and sclera were icteric. Upon examination of the abdomen no tenderness could be elicited, nor was there evidence of enlargement of the liver or spleen. Roentgen ray studies of the gastro-intestinal tract were negative.

The N. P. N. was 30, serum albumin 4.68, globulin 3.03. The serum bilirubin was 5.3 mg. per 100 cc.; blood Kahn negative; prothrombin activity 100 per cent. Cephalin flocculation test negative in 24 to 48 hours. Serum alkaline phosphatase 5.8 Bodansky units. There was no increase in the urine urobiligen.

During this period of hospitalization surgery was considered because the recurring attacks of jaundice were thought to be due to obstruction. However, the patient’s general condition began to improve with disappearance of the jaundice and a decrease in the icterus index from 44 to 18 units. She was allowed, therefore, to leave the hospital on
August 24, with instructions to report regularly to her attending physician.

Two weeks following discharge from the hospital the patient showed continued improvement with a drop in the icterus index to 7.6 units. One week later, however, she complained of a feeling of malaise and, at this time, the icterus index had increased to 33 units.

On September 27, 1951, she was admitted to the Wesley Long Hospital, complaining of a recurrence of the jaundice and itching which had been present for a period of 3 weeks. In the beginning of this attack she had experienced mild, indefinite pains over the abdomen, but the character and location of the pains did not suggest biliary colics. The clinical picture was essentially the same as on the previous hospital admission. There was, however, slight tenderness in the right subcostal region with a barely palpable liver edge. The icterus index was 34 units.

Operative Findings. On October 1, 1951, an exploratory laparotomy was performed. The gallbladder was markedly distended but it did not contain stones. In the region of the common hepatic duct a cystic tumor was found displacing the cystic duct to the right and apparently partially occluding its lumen. The cyst was about the size of a hen's egg and of the same contour. Clear mucoid fluid was aspirated from the cyst, and dark, thick bile was aspirated from the gallbladder. Upon opening the cystic tumor, multiple tiny cysts were found within its cavity. In attempting to remove the cyst wall from the duct, the lumen of the common hepatic duct was opened with the escape of normal bile. No dilatation of the ducts proximal to the growth was noted. A T-tube was inserted; convalescence was uneventful.

Pathologist's report: Sections of the cyst wall show it to be fibrotic with rather extensive hemorrhagic extravasation throughout the greater part. Within the wall itself are noted four or five small gland-like structures lined by a single layer of cuboidal or columnar epithelium. Histologically the gland structures do not have the appearance of glands of malignancy. Stout of the Presbyterian Hospital, New York, made the following comment on the microscopic slide: "The section confirms the diagnosis at operation. I assume it must have developed in one of the glands of the common hepatic duct. I have examined our files to see if we have had any such cases in the Presbyterian Hospital. There is not one recorded in the common hepatic duct. There have been two which developed in the common duct distal to the cystic duct; both, however, were mistaken for pancreatic cysts. Their walls and lining resembled your case."

Examination of the patient on November 29, 1952, showed her to be clinically well with no history of recurrence of the jaundice. The concentration of serum bilirubin was 0.3 mg. per 100 cc.

Diagnosis. It is obvious that a diagnosis can seldom if ever be made preoperatively. Some of these patients may complain of vague epigastric discomfort, anorexia, nausea, vomiting, intermittent or progressive jaundice; others may experience typical attacks of biliary colic complicated by cholangitis. It has been stated that some of these tumors may remain dormant for many years.

Pathology. In discussing the pathology of these tumors, Chu states: "Generally the smaller growths are of a solid or mixed type, while the larger ones are cystic or of the adenomatous variety. Grossly, the solid and mixed growths appear as various-sized, firm and well circumscribed tumors within the walls of the bile ducts. The cystadenoma, on the other hand, appears as a large, smooth, round or oval tumor, and frequently it shows multilocular spaces containing thick, viscid fluid on cut section. The cyst wall is composed of fibrous tissue in which blood vessels and small groups of acini may be found."

SUMMARY

A review of the incidence of benign neoplasms of the extrahepatic bile ducts has been presented.

The comparative rarity of these lesions to malignant tumors and idiopathic dilatation of the ducts has been considered.

A case of benign cyst of the common hepatic duct, causing intermittent jaundice has been described.

ACKNOWLEDGMENT

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DISCUSSION.—Dr. WALTMAN WALTERS, Rochester, Minn.; I was very much pleased to hear these two interesting papers. I think Dr. Cattell has done us a great favor and has added to our knowledge in this particularly important and somewhat uncertain field, in which patients continue to have attacks of pain after cholecystectomy. This condition has been referred to frequently as the post-cholecystectomy syndrome. Usually the causes of the pain which indicates varying degrees of obstruction can be demonstrated. Sometimes it is due to a stone in an elongated cystic duct, sometimes to incomplete removal of the gallbladder, with or without a stone remaining, and sometimes to the presence of stones in the common duct. These are the usual causes of pain after cholecystectomy. In addition, the relationship that dysfunction of the sphincter of Oddi and pancreatitis may have to these attacks of pain needs to be considered. This seems to me at present to be one of the most important problems in the field of abdominal surgery.

Recently I heard a most interesting paper by Mr. Kenneth Starr, an Australian surgeon. He described some cases of this type in which after exploratory choledochostomy, instead of instituting T-tube drainage of the common duct, he performed transduodenal sphincterotomy. In about 15 cases, if I remember correctly, he found stenosis of the pancreatic duct at the edge of the sphincter of Oddi. He diluted the outlet of this duct and then was able to demonstrate distal dilatation of the pancreatic duct. After dilatation of the stenosed outlet of the pancreatic duct, the pain disappeared.

If I may concentrate on Dr. Cattell's paper, I would like to make two or three comments. First, how can we prove whether a true organic narrowing or stricture of the sphincter of Oddi is present? Second, in those cases in which we have reason to believe from clinical examination, such as manometric readings, studies of intraductal pressure or cholangiography, that there is true stasis or obstruction, is division of the sphincter of Oddi sufficient to relieve that obstruction? Unfortunately, if a long T-tube is inserted, it is impossible to determine intraductal pressure, because the opaque medium flows so rapidly into the duodenum. That is why I do not use it except in cases in which the sphincter has been incised. Instead of using the small T-tube, for the last 16 years for each patient on whom I have explored the common bile duct, I have obtained postoperative cholangiograms and, on some patients, postoperative manometric studies. Such studies after operation show whether there is a true stricture of the sphincter of Oddi or a narrowing of the pancreatic portion of the common bile duct. If either or both are present, the duct will not empty properly and will not return to normal size. The T-tube should not be removed until the duct does both.

Most of the secondary operations which I have performed on the common bile duct have been due to common duct stones, strictures or pancreatitis; but in addition there have been cases in which none of these were demonstrable. In these, the assumption is that the pain is due to spasm or inflammation of the sphincter of Oddi. The latter may be with or without varying degrees of stenosis. In such cases, in which the type of pathologic change is uncertain, I have performed lateral choledochoduodenostomy when I have thought there might be dysfunction of the sphincter, because no stones could be found in the common duct but the duct was dilated at the time of operation. Unfortunately some of these patients have continued to have pain.

In other cases, I have performed sphincterotomy, but in some of these also, attacks of pain have begun again two or three months after operation. Unfortunately, I have had patients continue to have attacks of pain when both these operations had been performed. In these cases we have tried splanchnic nerve block first with procaine hydrochloride. If the pain was relieved, alcohol injec-
tions and occasionally splanchectomy have been done with varying results—none of which were too constant and frequently many were unsatisfactory.

Therefore, one of the problems, it seems to me, is this: How are you going to be sure that sphincterotomy will keep the lower end of the common bile duct open? In two cases I put short T-tubes through the choledocostomy incision after dividing the sphincter of Oddi. When cholangiograms were made about ten days later, spasm was still evident at the lower end of the duct. The spasm was like that seen in the stomach, not located just at the sphincter but in the region above the sphincter, as in congenital pyloric stenosis. Therefore, I think that if we are going to determine the effects of sphincterotomy, we must have methods of measuring, after operation, whether or not the sphincterotomy does relieve the intraductal pressure. That we can do only if we use a short T-tube and obtain postoperative cholangiograms and manometric readings.

Dr. Cattell has made an interesting contribution, and I think if all who perform sphincterotomy will carry out this program, at some future time we can pool our material and determine exactly what place sphincterotomy has in the treatment of the postcholecystectomy syndrome.

DR. WARREN H. COLE, Chicago, III.: I think Dr. Cattell has made a very important contribution. In my estimation these obstructions are much more common than are residual stones in the common duct as an explanation of persistent symptoms following cholecystectomy. Certainly, at the Illinois Research Hospital, we are finding many more cases of this type than residual stones in the common duct. Dr. Cattell mentioned two or three different types of obstruction at the sphincter of Oddi, some of which are inflammatory and some perhaps congenital. We also have had several cases of this type, but I would like to present briefly three cases with obstruction of a different type; in each the obstruction appeared to be congenital.

In one case the common duct emptied into the posterior wall of the pancreatic duct with a tiny opening no larger than 1.5 mm. in diameter. In two others there was stenosis of the common duct just proximal to the ampulla of Vater and, accordingly, proximal to the junction of the common duct with the pancreatic duct. Some of these obstructions proximal to the ampulla of Vater are probably due to pancreatitis, but in these latter two cases we found no evidence of pancreatitis; accordingly, we assumed that they must be congenital. In both cases the terminal end of the duct was firmly attached to the posterior wall of the duodenum, as is usually the case normally, and it was rather obvious that incision of the sphincter would not help them. Accordingly, we incised the posterior wall of the duodenum and the anterior wall of the terminal end of the common duct, thus enlarging the opening in the duodenum, with the hope that this would eliminate the stenosis of the terminal end of the duct. The diameter of the terminal end of the common duct is less than the remainder of the duct, but I am not sure how large a normal common duct proximal to the ampulla of Vater should be. After thinking it over I concluded that if a probe 6 mm. in diameter does not readily pass through this portion of the common duct, then some sort of stenosis must exist. One must ask if this obstruction is pancreatic in origin; if so, common duct decompression will cure it; if it is congenital, common duct decompression will not cure it, and one will have to do something to incise or enlarge the opening. I doubt whether mere dilation in this type of obstruction will cure the condition.

I would like to ask Dr. Cattell the size of the terminal end of the common duct that he would consider abnormal or normal.

DR. HOWARD MAJORNER, New Orleans, La.: I am glad to hear someone with the experience and the importance of Dr. Cattell present conclusions such as he has given us today. It makes me feel with more assurance that what we have been doing is correct. Forty-four times I have opened the duodenum and have seen before my eyes what happens at the lower end of the common duct and at the ampulla. In many of those cases a 2 mm. dilator placed in the common duct above was felt in the duodenum, and everyone in the operating team agreed that it was through the ampulla. When the duodenum was opened it was apparent that the ampulla was being pushed up against the opposite side of the duodenum and the dilator had not traversed it as we presumed. There is no question that stenosis occurs at the ampulla. Sounds should pass relatively easily, but sometimes it is necessary to milk the ampulla over the sound and with great difficulty, a 2 mm. dilator may be made to pass. We have not hesitated to cut the ampulla in many cases. We have found unexpected tumors in a few instances. We have found ulcers, and we have found that we had created a false passage with the sound passing around a stone into the duodenum, but not through the ampulla. In this group of cases there was one fatality, but it was not due to opening the duodenum; it was due to the fact that the patient died of uremia which was present to some extent at the time the operation was done.
I usually pull a long T-tube through the ampulla into the duodenum by a suture which has been placed in the duct by tying it onto a sound. These tubes must have multiple fenestrations to permit the free flow of pancreatic juice and bile. When the decision is made to open the duodenum, one must be very careful and not be reckless about it. I know that accidents have occurred. It is necessary to mobilize the duodenum and turn it forward, and there is peritoneum on the posterior surface just as there is on the anterior surface. A small opening is sufficient, and it must be closed securely.

Dr. Otto C. Brantigan, Baltimore, Maryland: It certainly was a pleasure to hear these two papers. I would like to comment on one aspect of biliary tract surgery. At Baltimore City Hospitals we have been particularly unhappy about our ability to determine the presence or absence of lesions in the common duct, by palpation or by palpation and probing with the common duct open. Even though a probe can be passed into the duodenum, a lesion of the common duct can be overlooked. Many years ago we began to do cholangiography before removing the drainage tube from the common duct. To our distress we found cases with stones still remaining after we had opened and carefully explored the common duct. This led to equipping our operating room in such a manner that we can do operative cholangiography. Diadrast is injected into the common duct through a small needle slightly larger than a hypodermic size. An x-ray film will adequately visualize the biliary duct system and the presence or absence of biliary tract pathology can be accurately determined with the abdomen open and the operation in progress. In the past few years since we have used this method, we have not had to do a secondary operation upon the biliary tract.

Dr. Richard B. Cattell, Boston, Mass. (closing): I am very grateful to the discussors, Dr. Walters, Dr. Cole, Dr. Mahorner and Dr. Brantigan, for emphasizing certain important points. Dr. Walters properly stressed the importance of determining the presence of persisting obstruction at the lower end of the common duct by means of postoperative cholangiogram when the short T-tube is used. In a few instances we have failed to note obstruction in the cholangiogram, yet later had return of symptoms requiring further operative intervention. From our experience, it is not wholly reliable. On the other hand, in our paper we have emphasized the importance of determining whether fibrosis is present during the initial operation and this has been done by mechanical means. As he implied, if the long T-tube is used, a cholangiogram is of no use in demonstrating obstruction at the lower end of the common duct.

Dr. Cole asked how large the normal sphincter of Oddi should be. We think that an opening of 3 mm. before dilatation is normal but, as we pointed out, there are many reasons why a probe of this or smaller size may not be passed successfully, even when the sphincter is of normal size. One of his cases had an anomalous entry of the common duct. We have excluded such cases and those with pancreatitis from this study.

We have increased the number of transduodenal sphincterotomies but only in those patients in whom exploration of the common duct from above reveals abnormal findings. In apparently advocating more frequent duodenotomies, I would like to sound a caution that it is not a simple procedure. It is best accomplished by elevation of the duodenum and the head of the pancreas so that the duct can be delivered into the wound. If the site of the papilla cannot be determined by palpation or by passing a probe, the incision into the duodenum is made in a longitudinal direction low in the second portion. The region of the ampulla can then be turned out to be as accessible as possible for sphincterotomy, following which the duodenum is closed transversely.

I would like the opportunity of discussing Dr. Lyday’s paper. He has presented an unusual case of obstructive jaundice and has obtained a fine result. I should like to record another patient with cyst of the biliary tract which produced obstructive jaundice. She was seen four or five years ago at the age of 26, with mild jaundice. A recent exploration had been done without determining the cause of obstruction. On opening the common duct I found a reddish, rounded, smooth mass presenting through the right hepatic duct into the common hepatic duct. It had the appearance of a rubber tube. When grasped, it could not be delivered. In order to reach it, the liver was split between the bed of the gallbladder and falciform ligament, and a large multilocular cyst was found within the liver substance with one of the loculi presenting down through the hepatic duct. It was completely excised and the liver was closed. She made an uncomplicated recovery and had no biliary fistula.
PRIMARY CARCINOMA OF THE THIRD PORTION OF THE DUODENUM*

DAVID HENRY PORE, M.D.

ATLANTA, GEORGIA

In a succession of surgical patients with similar symptomatology, it is the infrequent occurrence of the unusual or rare lesion that challenges the surgeon's diagnostic acumen and frequently his technical adaptability. Carcinoma of the duodenum is just such a lesion, mimicking, as it were, peptic ulcer, common duct stone, pyloric stenosis or intestinal obstruction, and presenting a complex surgical problem in the matter of resection and restoration of gastro-intestinal tract continuity. It is admittedly a rare lesion and may be encountered only once or twice during the experience of any one surgeon.

In addition to the rarity of these lesions, there are other factors which should be considered in the reporting of additional cases. The aggressive surgical attitude of the past decade toward malignancies of the pancreas and duodenum has been responsible for an increasing number of reports of successful resections. As a significant number of cases of one specific lesion becomes available for analysis, then surgical opinion, approach and management may be modified accordingly.

This report adds one case to the group of 16 cases reported to date of carcinomas of the infrapapillary portion of the duodenum subjected to resection.

Carcinoma of the duodenum has been the subject of several excellent treatises, notably those of Hoffman and Pack, and Dixon. The reader is referred to those for exhaustive reviews of the literature or a more extensive coverage of the total aspect of duodenal neoplasms.

Berger and Koppelman reported 58 cases of primary carcinoma of the infrapapillary portion of the duodenum. Shallow in 1950 stated that there were approximately 70 cases in the literature. In four-fifths of the cases, the diagnosis was made at autopsy or the lesion was inoperable.

Shallow et al. (1944) collected 12 cases of primary carcinoma of the third portion of the duodenum subjected to resection, and added one additional case.

In 1950, Shallow et al compiled a total of 15 cases, including two of their own.

Welborn and Bretz in 1949 reported one case not previously included by Shallow, which brings the total to date, with the addition of the case herein reported, to 17.

PATHOLOGY

The pathology of these carcinomas is similar in all respects to those which occur in other portions of the gastro-intestinal tract. The adenocarcinoma may occur as one of three types: (1) a scirrhous, annular tumor with overproduction of fibrous tissue and a tendency toward constriction and obstruction; (2) a bulky polypoid intraluminal mass, prone to ulceration, partial obstruction and hemorrhage; (3) colloid carcinoma with mucoid degeneration.

All types of these tumors may cause obstruction and if sufficient time elapses, they will invade surrounding structures, including the pancreas and mesenteric vessels.
The scirrhous tumors tend to grow slowly, and in these, invasion may occur late.

**SYMPTOMATOLOGY**

The symptoms will depend largely upon the characteristics of the individual tumor. In friable or bulky soft tumors, hemorrhage or symptoms of ulceration may simulate benign duodenal ulcer, although in this location pain may be referred to the midabdomen rather than the epigastrium. Partial or complete obstruction will give a clinical picture congruous with that of pyloric obstruction except for the addition of bile to the vomitus. Dehydration, chloride depletion, electrolyte imbalance and tetany may appear, dependent upon duration of obstruction, character of the vomitus, and the type and amount of replacement therapy. Additional symptoms of obstruction are weight loss, anorexia, eructations, upper abdominal distention with succussion splash.

**PHYSICAL FINDINGS**

In cases not presenting marked obstruction or advanced growth, the physical signs will be few. A palpable upper abdominal mass may be felt in about 15 to 20 per cent of cases, particularly if there has been great loss of weight. If felt, the mass will be relatively fixed and predominantly to the right of the midline. A distended stomach may be outlined and visible peristaltic waves will occasionally be observed passing across the epigastrium. Auscultation may disclose a succussion splash or sounds of gas or liquid being forced past a point of obstruction.

**ROENTGENOLOGICAL FINDINGS**

In addition to an increased index of suspicion on the part of the surgeon, the roentgenologist shares an even greater responsibility in the detection and diagnosis of these lesions. In all examinations of the upper gastro-intestinal tract, he should be encouraged to extend his examination beyond the pylorus and duodenal cap, and to examine carefully all portions of the duodenum. This is especially true when dealing with an obstructed hollow viscus such as the stomach, where examination is uniformly difficult. This is shown in the case reported herein, where a normal outline of the dilated stomach and the first portion of the duodenum had been obtained in another hospital prior to the patient's admission.

The lesion is visualized as a defect in the third portion of the barium-filled duodenum. Depending upon the degree of encroachment upon the lumen of the gut, the amount of obstruction can be demonstrated and the gross outline of the tumor defined.

In the presence of complete obstruction, examination with barium is difficult, and may be facilitated by gastric and duodenal suction for several hours prior to examination.

**TREATMENT**

Many of these patients present themselves in varying degrees of malnutrition, dehydration and electrolyte imbalance because of partial or complete duodenal obstruction. Even prior to definitive diagnostic procedures, treatment of these deficiencies must be pursued vigorously. Replacement therapy employing water, electrolytes, blood and protein hydrolysates should be guided by appropriate laboratory studies, especially serum potassium and chloride levels, CO2 combining power of the plasma and urinary chloride excretion.

A few patients will present the problem of upper gastro-intestinal hemorrhage and should receive essentially the same treatment regimen as bleeding peptic ulcer. This will include adequate blood replacement, hydration, sedation and perhaps the use of topical thrombin therapy.

As soon as the patient's condition permits, diagnostic measures may be under-
taken, while at the same time, therapeutic
efforts must be directed toward preparing
the patient for operation as soon as possible,
whether the decision for operative interven-
tion has been definitely made or not. Once
the diagnosis is reasonably established, sur-
gery is mandatory. There is in almost every
case a negative protein balance, from re-
duced food intake or actual obstruction.

Recognizing that the parenteral administra-
tion of blood, glucose or protein hydrolysates
will rarely achieve a positive nitrogen bal-
ance, the surgeon must, therefore, make
every effort to restore the function of the
astro-intestinal tract and begin oral feed-
ing as early as possible.

The surgical approach to adenocarcinoma
of the third portion of the duodenum
should have as its aim the performance of
"ideal cancer operation," in which the pri-
mary lesion is resected in bloc with an ade-
quate margin of normal tissue, together
with adjacent lymph nodes and their drain-
age areas, insofar as is technically feasible.\(^2\)

In the third portion of the duodenum, the
proximity of the mesenteric and great ves-
sels, pancreas and biliary system makes the
achievement of this ideal most difficult. If
the lesion is found early, with no gross
evidence of distal involvement past the
bowel wall, a local resection with restora-
tion of continuity by end-to-end anastomo-
sis of the second part of the duodenum to
the jejunum may be performed. For those
lesions which have involved structures out-
side the duodenal wall, careful search
should be made to determine the limit of
spread, so that a decision may be reached
whether to perform a palliative local resec-
tion, or to attempt a more radical procedure
with a possibility of cure.

This more extensive resection will usually
require total duodenumectomy and a partial or
total pancreatectomy, with reestablishment
of gastro-intestinal tract continuity by any
one of several accepted technics. As these
technics of radical surgery are applied to
tumors of this region with increasing fre-
cquency, we may look forward to an increas-
ing number of cures. The only absolute
contraindications to pancreatoduodenec-
tomy for carcinoma in this portion of the
duodenum are metastasis distal to the limits
of possible tissue removal and involvement
of the superior mesenteric or great vessels
by direct invasion.

Postoperatively, these patients require no
unusual care. Gastric suction may be con-
tinued for several days until normal peri-
stalsis is evident, and beginning with fluids,
the oral intake is rapidly increased until a
full diet is being taken. The use of antibi-
tics and parenteral administration of
blood, glucose and fluid is indicated in
most cases.

CASE REPORT

A 55-year-old white male machinist was ad-
mitted to the hospital because of weakness and
weight loss of 3 months' duration, accompanied
during the 3 weeks prior to admission by nausea
and vomiting occurring once or twice daily. Shortly
before admission the patient noted vague epigastric
discomfort and a sensation of gurgling and splash-
ing in the upper abdomen.

The past history revealed no previous similar
episodes, serious illnesses, hospital admissions, or
surgery other than given below. The family history
was essentially noncontributory.

The patient had been hospitalized in another
city with a provisional diagnosis of Addison's dis-

case and had received treatment by the adminis-
tration of parenteral fluids and the subcutaneous
implantation of a pellet of desoxycorticosterone
acetate. Roentgenological examination of the
stomach using barium was reported as showing
only pylorospasm.

On admission the oral temperature was 98.6°F,
pulse 80, respiration 20 per minute and the blood
pressure 96/70. There was evidence of cachexia
and marked dehydration. The abdomen was
scaphoid and no masses were palpable. The re-
mainder of the physical examination was not re-
markable, except for a soft apical systolic murmur
and mild dorsal kyphosis.

From the clinical findings, laboratory data and
electrocardiographic examination, the presence of
severe dehydration, chloride loss, azotemia and
lowered serum potassium was established. The desoxycorticosterone acetate pellet was removed shortly after admission. Replacement therapy was begun, using balanced salt solutions containing therapeutic amounts of potassium chloride. Constant nasogastric suction was instituted. The response to replacement of fluids and the correction of sodium and potassium imbalance was immediate. By the fourth hospital day the electrocardiogram had reverted to normal and the clinical signs of potassium deficiency had decreased markedly. There was evidence of complete obstruction at or distal to the pylorus, as evidenced by the quantity of fluid removed by suction and inability to retain fluids given by mouth.

Roentgenologic examination with barium revealed marked gastric retention with almost complete obstruction of the duodenum, at the junction of the second and third portions. The lumen was markedly narrowed from an intrinsic lesion, having the characteristics of a primary malignancy.

On the fifth hospital day after fluid and electrolyte imbalance had been corrected, an exploratory laparotomy was performed. An annular constricting lesion was found at the junction of the second and third portion of the duodenum. The lesion was freely movable and there was gross evidence of the involvement of regional nodes beyond limits of complete local or radical extirpation. A block resection was performed, with a 5 cm. cuff of normal duodenum on either side of the lesion. An end-to-side anastomosis duodenum to proximal jejunum was then established.

The postoperative convalescence was uneventful. Gastric suction was used until the fourth postoperative day when oral feeding was begun. The patient was discharged on the eighth postoperative day, asymptomatic and taking 3 meals daily without discomfort.

The pathologic examination revealed an annular adenocarcinoma of the third portion of the duodenum with marked narrowing of the lumen. Metastasis to five regional lymph nodes was demonstrable.

The patient, when last examined (November 1, 1952), approximately five months after discharge, was asymptomatic and had gained considerable weight.

SUMMARY

The surgical problem presented by adenocarcinoma of the infrapapillary portion of the duodenum has been discussed from the aspects of incidence, pathology, symptomatology, diagnosis and treatment. It is a rare lesion, and is one which is curable if efforts are directed toward early diagnosis and radical resection techniques followed.

In the absence of metastasis distal to the limits of resectability, local resection or radical pancreatoduodenectomy should be performed.

A case of adenocarcinoma of the third portion of the duodenum is reported, bringing to 17 the total reported number of these lesions in which resection was performed.

BIBLIOGRAPHY


DISCUSSION.—Dr. Richard B. Cattell, Boston, Mass.: This has been a very interesting presentation by Dr. Poer and I should like to discuss it from two points of view. As he pointed out, the technical difficulties in resection of carcinoma in the second and third portions of the duodenum
are many, and the prognosis is poor. Our experience supports his findings. We have removed seven carcinomas in this area by pancreatoduodenal resection, yet no patient lived for five years. Two lived over three years and the other five were dead within two years.

The second point is a technical one which I hope may be helpful to you in meeting this surgical problem. There are other lesions occurring in this portion of the duodenum which may require resection, and I would like to describe briefly what seems to be the best surgical approach and exposure of this area. If one reverses the anatomic embryologic rotation of the colon and small intestine, the third and fourth portions of the duodenum can be made completely extraperitoneal. To accomplish this, the entire right colon and the right half of the transverse colon are freed up, and the avascular peritoneal attachment of the small bowel mesentry is incised from the right lower quadrant up to and including the ligament of Treitz. All of the right colon and all of the small intestine can then be displaced onto the chest wall and the surgeon has a direct exposure of the third and fourth portions of the duodenum which will permit whatever type of radical resection seems necessary. We have utilized this a number of times and I can assure you it greatly facilitates an operation in this area.
ANNULAR PANCREAS PRODUCING DUODENAL OBSTRUCTION

HARWELL WILSON, M.D.
MEMPHIS, TENNESSEE

AND

JAMES H. BUSHART, M.D.
LAWTON, OKLAHOMA

FROM THE DEPARTMENT OF SURGERY OF THE UNIVERSITY OF TENNESSEE COLLEGE OF MEDICINE AND THE JOHN GASTON HOSPITAL
MEMPHIS, TENNESSEE

Annular pancreas producing duodenal obstruction is now a well recognized clinical entity. Lehman,1® McNaught,1® Payne,21 and others have made significant contributions to the understanding of this condition.

The relative rarity of the condition, however, is emphasized by the fact that we have been able to find in the literature only 28 surgically treated cases. To this group we are adding three cases of annular pancreas treated in children. Only a slightly larger number of such cases has been reported as being found at necropsy or in the anatomical laboratory. It is probable that the lesion occurs much more frequently than was previously thought to be the case. No doubt, as surgeons and pathologists become more aware of the condition, it will be found more frequently. This statement is emphasized by the fact that of the 31 cases treated by surgery, 21 have been reported in the last ten years.

Annular pancreas has been reported as a cause of duodenal obstruction in cases varying in age from two days to 74 years. Only nine of these cases were children. It has occurred in 21 males and ten females.

The anatomical abnormality present consists of a thin band of pancreatic tissue arising from the head of the pancreas and completely encircling the duodenum. The embryological development of the annular pancreas has been thoroughly discussed by McNaught.1® Both McNaught and Cunningham® have pointed out the separate duct system which confirms the opinion held by most authors writing on this subject that the annular pancreas develops from the ventral anlage.

Annular pancreas may exist without producing symptoms, since it has been found at necropsy in individuals who gave no history of duodenal obstruction. In the majority of the surgical cases, the symptoms were those of a high intestinal obstruction; however, a few were reported incidental to other findings. In most cases, roentgen ray examination will show an obstruction of the second portion of the duodenum. In two of our cases, the correct diagnosis was made by roentgen ray examination.

Two surgical approaches have been used in the management of this condition. The surgical treatment has consisted in some cases of a direct attack on the annular pancreas in an attempt to relieve the duodenal obstruction by excision of the constricting band of pancreatic tissue. In some instances this has been followed by pancreatic fistula formation. Another complication reported, following resection of the annular pancreas, is pancreatitis.

The second method of relieving the duodenal obstruction surgically has consisted of some type of by-passing operation. This has usually been either a gastrojejunostomy or a duodenojejunostomy. The by-passing procedures appear much less likely to be followed by fistula formation, pancreatitis and other complications. Because of this, in the cases being reported we chose to use by-passing procedures.

CASE REPORTS

Case 1.—John Gaston Hospital, #183956. L. E. P., a colored male, age 18 days. At birth initial examination had revealed a normal appearing male child with no apparent defects. Birth weight was 7 pounds and 13 ounces. He received normal newborn care and was discharged home. On the fifth day it was noted that he vomited profusely after each feeding. The vomitus contained no bile. He was treated in the Outpatient Department for a period of three days with antispasmodics. A tentative diagnosis of pylorospasm was made. The vomiting remained constant following meals and bowel movements were described as scanty. He was admitted to the Pediatric Department of the hospital June 20, 1951. The body weight was now 6 pounds and 7 ounces. Physical examination was essentially negative with the exception of evidence of marked dehydration.

A tentative diagnosis of pylorospasm was made and medical treatment instituted with no improvement. On June 28, a gastro-intestinal roentgenologic examination was made. The barium meal was not seen to pass beyond the second portion of the duodenum. At one hour, only a small amount of barium had passed from the stomach, and at two hours, there was still 90 per cent retention of the barium in the stomach and first portion of the duodenum.

Surgical consultation was obtained and the decision to operate upon the child for duodenal obstruction was made. On July 3, 1951, an exploratory laparotomy was done. An upper right rectus incision was made. Exploration revealed the first and second portions of the duodenum to be dilated two to three times normal size. This dilatation was proximal to an annular band of pancreatic tissue that completely encircled the second portion of the duodenum. The ring was 1 cm. in width and 0.5 cm. in thickness. No attempt at division of the ring was made. It was elected to carry out a by-passing procedure. A posterior gastrojejunostomy was done. The immediate postoperative course was uneventful. The child ceased to vomit and took his formula well following operation. He was discharged on the 35th postoperative day. He had been retained in the hospital due to the fact that it was thought that the parents could not adequately care for the child. His weight gain had been constant. He was last seen June 16, 1952, when his development was normal and his body weight was 18 lbs.

Case 2.—John Gaston Hospital, #169639. E. B., Jr., a colored male, age 20 months, was admitted to The John Gaston Hospital May 13, 1952, with a chief complaint of vomiting following meals since birth. The periods of vomiting had been intermittent in character. He had been free of vomiting for
TABLE I.—Patients with Annular Pancreas Treated by Operation.

<table>
<thead>
<tr>
<th>Case</th>
<th>Reported by</th>
<th>Age and Sex</th>
<th>Operation</th>
<th>Result</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vidal 1905</td>
<td>Male</td>
<td>Posterior gastro-enterostomy</td>
<td>Cure</td>
<td>Had congenital atresia of duodenum.</td>
</tr>
<tr>
<td>2</td>
<td>dos Santos 1906</td>
<td>Female</td>
<td>Posterior gastro-enterostomy</td>
<td>Died (pneumonia)</td>
<td>Diagnosis at postmortem.</td>
</tr>
<tr>
<td>3</td>
<td>Lerat 1908</td>
<td>Female</td>
<td>Resection of pancreatic ring</td>
<td>Cure</td>
<td>Drainage ceased on 13th day.</td>
</tr>
<tr>
<td>4</td>
<td>Smetana 1928</td>
<td>Male</td>
<td>Posterior gastro-enterostomy</td>
<td>Died</td>
<td>Diagnosis at postmortem.</td>
</tr>
<tr>
<td>5</td>
<td>Howard 1930</td>
<td>Female</td>
<td>Division of ring</td>
<td>Cure</td>
<td>Developed pancreatic fistula, second operation for drainage.</td>
</tr>
<tr>
<td>6</td>
<td>Brines 1930</td>
<td>Male</td>
<td>Drainage of pancreatic fistula</td>
<td>Died</td>
<td>Diagnosis at postmortem.</td>
</tr>
<tr>
<td>7</td>
<td>Zech 1931</td>
<td>Female</td>
<td>Division of ring with Heineke-Mikulicz procedure on duodenum</td>
<td>Cure</td>
<td>Small pancreatic fistula.</td>
</tr>
<tr>
<td>8</td>
<td>Brines 1931</td>
<td>Male</td>
<td>Posterior gastro-enterostomy</td>
<td>Died</td>
<td>Postoperative x-ray revealed persistent deformity of the duodenum.</td>
</tr>
<tr>
<td>9</td>
<td>Truelson 1940</td>
<td>Male</td>
<td>Posterior gastro-enterostomy plastic on duodenum</td>
<td>Recovered</td>
<td>Persistent deformity of the duodenum.</td>
</tr>
<tr>
<td>10</td>
<td>Lehman 1942</td>
<td>Male</td>
<td>Partial resection of ring</td>
<td>Recovered</td>
<td>Postoperative x-ray revealed persistent deformity of the duodenum.</td>
</tr>
<tr>
<td>11</td>
<td>Gross and Chisholm</td>
<td>Female</td>
<td>Duodenojejunostomy</td>
<td>Cure</td>
<td>Also had benign gastric ulcer.</td>
</tr>
<tr>
<td>12</td>
<td>Custer and Waugh</td>
<td>Male</td>
<td>Partial gastric resection with gastrojejunostomy</td>
<td>Cure</td>
<td>Developed subdiaphragmatic abscess and duodenal fistula.</td>
</tr>
<tr>
<td>13</td>
<td>Goldyne and Carlson</td>
<td>Male</td>
<td>Partial resection of ring</td>
<td>Cure</td>
<td>Also had benign gastric ulcer.</td>
</tr>
<tr>
<td>14</td>
<td>Brown, Bingham and Cronk 1948</td>
<td>Female</td>
<td>Division of ring, duodenojejunostomy</td>
<td>Died</td>
<td>Developed subdiaphragmatic abscess and duodenal fistula.</td>
</tr>
<tr>
<td>15</td>
<td>Burger and Alrich 1949</td>
<td>Female</td>
<td>Partial resection of ring, Heineke-Mikulicz procedure on duodenum</td>
<td>Died</td>
<td>Also had benign gastric ulcer.</td>
</tr>
<tr>
<td>16</td>
<td>Olmacher and Marshall 1950</td>
<td>Male</td>
<td>Partial gastrectomy and gastrojejunostomy</td>
<td>Cure</td>
<td>Developed postoperative local pancreatitis with resultant obstructing scar formation.</td>
</tr>
<tr>
<td>17</td>
<td>Baker and Wilhelm 1950</td>
<td>Male</td>
<td>Partial gastrectomy with gastrojejunostomy and duodenojejunostomy</td>
<td>Cure</td>
<td>Persistent deformity of the duodenum.</td>
</tr>
<tr>
<td>18</td>
<td>Ravich and Woods 1950</td>
<td>Male</td>
<td>Partial resection of ring—duodenojejunostomy 37 days later</td>
<td>Cure</td>
<td>Malrotation of intestine, duodenal atresia.</td>
</tr>
<tr>
<td>19</td>
<td>Ravich and Woods 1950</td>
<td>Female</td>
<td>Duodenojejunostomy</td>
<td>Cure</td>
<td>Malrotation of intestine, duodenal atresia.</td>
</tr>
<tr>
<td>20</td>
<td>Ravich and Woods 1950</td>
<td>Male</td>
<td>Gastroduodenostomy</td>
<td>Cure</td>
<td>Malrotation of intestine, duodenal atresia.</td>
</tr>
<tr>
<td>21</td>
<td>Haden 1950</td>
<td>Male</td>
<td>Partial resection of ring</td>
<td>Cure</td>
<td>Persistence of duodenal obstruction.</td>
</tr>
<tr>
<td>22</td>
<td>Conroy and Woelfel 1951</td>
<td>Female</td>
<td>Gastro-enterostomy</td>
<td>Cure</td>
<td>Also had duodenal ulcer, postoperative jejunal fistula repaired by Roux exclusion and resection of fistula.</td>
</tr>
<tr>
<td>23</td>
<td>Conroy and Woelfel 1951</td>
<td>Male</td>
<td>Division of ring</td>
<td>Cure</td>
<td>Persistence of duodenal obstruction.</td>
</tr>
<tr>
<td>24</td>
<td>Payne 1951</td>
<td>Male</td>
<td>Partial resection of ring</td>
<td>Recovered</td>
<td>Also had duodenal ulcer, postoperative jejunal fistula repaired by Roux exclusion and resection of fistula.</td>
</tr>
<tr>
<td>25</td>
<td>Cattell 1951</td>
<td>Male</td>
<td>Division of ring, partial gastrectomy</td>
<td>Cure</td>
<td>Persistence of duodenal obstruction.</td>
</tr>
<tr>
<td>26</td>
<td>Anderson and Wapshaw 1951</td>
<td>Female</td>
<td>Resection of ring</td>
<td>Cure</td>
<td>Persistence of duodenal obstruction.</td>
</tr>
<tr>
<td>27</td>
<td>Wakeley 1951</td>
<td>Male</td>
<td>Resection of ring</td>
<td>Cure</td>
<td>Persistence of duodenal obstruction.</td>
</tr>
</tbody>
</table>
FIG. 3.—(Case 2) Treated by posterior duodeno-
jejunostomy.

portions of the duodenum were markedly dilated. During the period of fluoroscopic examination, no barium passed from the second portion of the duodenum. After four hours, 15 per cent had passed beyond the obstructed area of the duodenum. A tentative diagnosis of annular pancreas was made.

An exploratory operation was done May 19, 1952. A dilated proximal duodenum was found that was four to five times normal size. It was thickened and edematous. An annular pancreas was found low on the second portion of the duodenum, causing almost complete obstruction. A duodenojejunostomy was then done, by-passing the constricting annular pancreas. This was done by making a window in an avascular portion of the transverse mesocolon, to the right of the middle colic artery, bringing the dilated duodenum through this window and making a side-to-side anastomosis with the proximal jejunum. The postoperative recovery was delayed a few days while the patient was being taught to eat solid food. He was last seen June 18, 1952. He had not vomited since the operation, and had gained weight and tolerated solid foods well.

Case 3.—John Gaston Hospital, #206012. B. B. D., a colored male, seven days old, was admitted to The John Gaston Hospital on September 1, 1952, with history of having lost three pounds since birth because of repeated vomiting, listlessness and failure to take feedings. Vomiting was said to have occurred chiefly during the 24 hours prior to hospital admission. The delivery had been normal. Examination revealed marked dehydration, and the rectal temperature was 104.6°F. No abdominal masses were palpable. Laboratory studies at time of admission revealed 5.3 million red blood cells, 17,000 white blood cells, CO₂—90 volumes per cent, chlorides—490 mg. per cent.

Immediate steps were taken to correct the electrolyte balance and the following day roentgen examination revealed a large amount of air to be present in the stomach and duodenum, the air extending down to the second portion of the duodenum where it stopped abruptly. A small amount of lipiodol was placed in the stomach and the radiologist reported obstruction of second portion of the duodenum due to annular pancreas.

On September 3, 1952, 48 hours after admission, laparotomy was performed and a ring of pancreatic tissue was found obstructing the second portion of the duodenum. A posterior duodenojejunostomy was performed without technical difficulty. The stomach had been aspirated with a small catheter prior to operation and the patient was kept in a slight Trendelenburg position during operation; however, it was the impression of the surgeon that some gastric secretion was probably aspirated during the course of the operation. The

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blood appeared unusually dark for two or three minutes and the operation was discontinued while suction was instituted.

The day following operation, the baby was noted to have some respiratory difficulty; however, radiological examination at that time revealed no evidence of disease in the heart or lungs. Fortyeight hours after operation the baby appeared cyanotic and breathing became labored. Roentgen examination at this time revealed patchy atelectasis in both lung fields, being more marked in the right upper lobe. Antibiotics were given from the time of operation. The patient expired on the third postoperative day, and while permission for autopsy was refused, it was believed that death was due to respiratory complications, probably from aspiration pneumonia.

DISCUSSION

In the treated cases of annular pancreas, surgery has been the only course followed. In the 31 cases that have been treated surgically, annular pancreas has been recognized in 27 instances, and in four cases the diagnosis has been made at postmortem. The operative procedures on these 27 recognized cases have generally fallen into two categories. One a direct attack on the constricting band, and two, operations to by-pass the obstructing lesion.

In 14 cases a direct attack on the ring was made. Two of these cases had complementary procedures (Heineke-Mikulicz pyloroplasty) at the time of the original surgery, and one of the 14 had a duodenojejunostomy 37 days later. Complications occurring in this group of 14 included four patients who developed a pancreatic fistula, two patients who recovered but had persistent symptoms of obstruction, and one patient who developed postoperative pancreatitis with resultant obstructing scar formation. In this group of 14, where the ring was excised, there were two deaths.

In 12 cases where the annular pancreas was recognized at the time of surgery, a by-passing procedure was done. Four of these were posterior gastrojejunostomies, four were duodenojejunostomies, three were partial gastric resections with gastrojejunostomy, and one was a gastroduodenostomy. All of these patients, except one, recovered completely without complications. One died of aspiration pneumonia. One case reported by Cattell was operated upon for a duodenal obstruction found during surgery for a patient who was operated upon for an annular pancreas.

For a summary of the treatment of annular pancreas as reported by others and by various other investigators, see Table 1.
for a duodenal ulcer. In addition to the duodenal ulcer, an annular pancreas was found. The annular pancreas was divided during the course of the partial gastrectomy, a pancreatic fistula developed and there was also a disruption of the wound. This patient eventually recovered. The complications in this case, as emphasized by Cattell, resulted from dividing the ring of pancreatic tissue.

Four of the 31 surgically treated cases of annular pancreas were diagnosed at post-mortem. Of this group, three had a posterior gastro-enterostomy and one had drainage of an acute pancreatitis. The cause of death in two of the cases treated by posterior gastro-enterostomy was listed as respiratory infection.

SUMMARY AND CONCLUSIONS

1. Twenty-eight cases of surgically treated annular pancreas have been reviewed from the literature.
2. Three additional cases of annular pancreas producing duodenal obstruction are reported.
3. The two surgical approaches which have been used are discussed: (a) a direct attack on the constricting ring of pancreatic tissue and (b) a by-passing procedure.
4. The evidence indicates that a by-passing procedure is the method of choice in the treatment of annular pancreas producing duodenal obstruction.

BIBLIOGRAPHY

DISCUSSION.—Dr. ROBERT L. PAYNE, JR., Norfolk, Virginia: I should like to make one additional point on a case reported here before. This patient, an adult male in whom the annulus had been resected, continued to have symptoms of obstruction postoperatively.

(Slide) This shows a roentgenogram taken postoperatively after the annulus had been resected; here is the large duodenum.

(Slide) This is a drawing of the annulus, and note the large duodenum here. At the second operation it was apparent that the annulus had been entirely removed and that there was no actual constriction of the duodenum from scar tissue. One could pass fingers through this portion of the duodenum without difficulty. However, the large bulky duodenum hanging over and fixed posteriorly, was in itself the cause of the obstruction. I think this adds a little further weight to the belief that resection of the annulus in itself is not a satisfactory procedure.

I should like to congratulate Dr. Wilson on a most interesting and excellent paper.

Dr. Mark M. Ravitch, New York, N. Y.: This fascinating group of cases was very lucidly presented. I do want to ask Dr. Wilson whether he would take the time to tell us why it is that, with a congenital lesion which has been present since some time before birth, symptoms in something like 18 out of 40 cases have not come on until the fourth or fifth decade of life. This is the only congenital lesion in the intestinal tract that behaves in that way. I hope we can get our radiologists to restrain their enthusiasm and to be satisfied with their accurate diagnosis with air in the bowel, and not to insist upon a contrast film with barium, which is so dangerous in the newborn and adds nothing.

Dr. Edwin P. Lehman, Charlottesville, Va.: When I discussed Dr. Payne’s paper on this subject before this Association two years ago I was able to report a case of annular pancreas from the Department of Surgery of the Hospital of the University of Virginia, in which Dr. H. L. Archer made a correct preoperative diagnosis. Today I am going to report another instance in which the surgeon did not make a preoperative diagnosis.

The patient was a woman aged 53, whose story went back about five years. She complained of epigastric and right upper quadrant pain, with nausea and vomiting. At times the pain radiated around the right costal margin to the right scapular region. For the past two or three weeks she had had practically continuous pain with nausea and vomiting when taking even liquids. She had lost 40 pounds but was still rather obese. There was localized epigastric tenderness on the right and also in the left lower quadrant. Two gallbladder roentgenograms showed a normally functioning gallbladder without evidence of stones.

The Urological Service made a diagnosis of neuromuscular defect of the lower half of each ureter, worse on the left. A gastro-intestinal series showed two diverticula of the second portion of the duodenum and an area of constriction with partial obstruction between the first and second portions of the duodenum. Roentgenologic diagnosis was “diverticulitis resulting in partial obstruction of the duodenum.”

At operation an annular pancreas was found. The ring was divided and the two stumps doubly ligated with chronic catgut and fine silk. Since the anterior half of the duodenal wall did not balloon out satisfactorily an incision was made in the serosal surface of the duodenum and fibrous bands divided, resulting in complete ballooning of the duodenum. The patient had a smooth postoperative course and left the hospital on the fourteenth day after admission, eight days after operation. She was restudied three weeks later and a partial obstruction of the duodenum was observed on roentgenologic examination. Clinically she was doing well without symptoms.

Dr. Wilson has come to the conclusion that most recent writers have reached, namely, that the better treatment is a short-circuiting operation rather than a direct attack on the constricting ring. I am inclined to agree. I do not believe, however, that the danger of fistula is very great provided the division of the ring is made at the site of origin of the duct of the annulus, namely, as far to the left anteriorly as possible. The case just reported healed per primam and the majority of other cases have healed the same way.

Annular pancreas may be the greatest single cause of obstruction in the duodenum in the second portion. I want to congratulate Dr. Wilson on being able to make a preoperative diagnosis in two out of three cases. This is an excellent record.

Dr. Harwell Wilson, Memphis, Tenn. (closing): I would like to thank Dr. Payne, Dr. Ravitch
ANNULAR PANCREAS PRODUCING DUODENAL OBSTRUCTION

and Dr. Lehman for their discussion. With reference to Dr. Ravitch's question as to why so many of these individuals do not have symptoms until later in life, I certainly do not know the answer and had hoped he would give it to us. It is true that all three of the patients that we have had within the last year and a half have been young children; the majority of the cases reported in the literature, however, are in older individuals. I also agree wholeheartedly with his comment with reference to being very careful in roentgenologic examination of infants. I think he might even have carried it a step further and called attention to the fact that sometimes we get into trouble with lesions of the left side of the colon by actually precipitating acute obstruction, where too much barium is pushed beyond an obstructive lesion. At least in Memphis, it may be a little more difficult for us at times to control the roentgenologist than it is in Baltimore, but we are appreciative of the help the roentgenologist has given us.

I think we all appreciate the discussion by Dr. Lehman, because I think we all feel that his article in 1942 made us very much aware of this condition, and it was only recently that we had an opportunity to see it.
THE RELATION BETWEEN INTERNAL JUGULAR VEIN PRESSURE AND CEREBROSPINAL FLUID PRESSURE IN THE OPERATION OF RADICAL NECK DISSECTION*

HENRY P. ROYSTER, M.D.

PHILADELPHIA, PENNSYLVANIA

FROM THE HARRISON DEPARTMENT OF SURGICAL RESEARCH, SCHOOLS OF MEDICINE, UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA

It is known that compression or ligation of one or both internal jugular veins may be followed by a rise in the pressure of the cerebrospinal fluid. In the unilateral radical neck dissection, the internal jugular vein with its cervical collaterals is excised and ligated at the clavicle, and at the level of the mastoid bone, with the result that the greater part of the venous cranial outflow on that side is blocked and there is usually an immediate elevation of cerebrospinal fluid pressure. In some patients undergoing radical neck dissection the ligation of one internal jugular vein may be followed by a steep rise in pressure within the vein and the cerebrospinal space. Occasionally, death has occurred as an aftermath.

Several reports have described the sequelae following unilateral or bilateral internal jugular vein ligation and have inferred that the interruption of the jugulars is the sole cause of the high intracranial pressure, both in the venous and fluid systems. They have correctly cited the work of Batson, of Gius and Grier, who demonstrated the collateral venous circulation from the cranium and its adaptation to the change in blood flow. Edwards and Woodhall have shown the anatomical variations in the cranial venous sinuses that may account for bizarre pressure changes after jugular block.

Although the increase in venous pressure due to ligation of the internal jugular vein and adjacent collaterals is extremely important, nevertheless the coincident rise in intracranial pressure must be analyzed in the light of other factors that may influence it as well.

It is the purpose of this paper to show that the rise in venous pressure after single or double ligation of the jugular veins is extremely variable and that it is only one, though often the most important one, of the factors concerned in the elevation of cerebrospinal fluid pressure.

METHODS

The study consisted of observations on 32 patients who underwent 34 unilateral or bilateral radical neck dissections. The diagnoses were: squamous cell carcinoma of the oral cavity and upper respiratory tract with cervical metastasis or suspected metastasis, 21; carcinoma of the thyroid, 6; carcinoma of the parotid gland, 2; malignant melanoma of the auricle, 2; and cylindroma of the tongue, 1.

Preoperative Queckenstedt tests were performed on seven patients. Internal jugular vein pressure measurements were made in all patients. This was accomplished with the patient under general anesthesia soon after the start of the operation, and after the external jugular vein had been ligated and the platysma cut away from the clavicle in order to reduce collateral venous outflow. The venous pressure was measured at 3 cm above the clavicle. If the patient was sitting, the pressure was noted directly under the clavicle, if the patient was supine.

Blood was drawn from the arm for the immediate tests. The results were considered meaningful so that they might be serially compared and fluid measurements taken by Sugarbaker.

Lumbar punctures were done one week after surgery and repeated on the second week. Half of the patients had an insertion without prior lumbar puncture.

Symptoms were noted during the period of postoperative fluctuation of pressure and fluid measurements and data were taken.

The patient is the recipient of the operation and the neck dissection is performed, and the patient is placed in one of the positions described.

lateral circulation. The level of the resting pressure was measured in centimeters of 3 per cent sodium citrate solution by means of an ordinary venous pressure manometer connected to a 17-gauge short-beveled needle introduced at a point just above the clavicle. Tightening of a ligature on the cardiac side of the needle blocked the flow of blood from the brain. The pressure rise noted in the citrate column was read directly until stable. Normal resting internal jugular bulb pressures in unanesthetized subjects obtained by inserting an 18-gauge needle at the level of the tip of the mastoid were supplied by Dr. Eugene E. Conner of the Department of Anesthesiology, using the Lilly capacitance gauge. These pressures were taken about 13 cm. above the level of the measurements in this study.

In seven patients continuous direct recordings of cerebrospinal fluid pressure by means of lumbar puncture were performed so that internal jugular vein pressure might be simultaneously compared. The spinal fluid manometer was arranged as advised by Sugarbaker. Blood pressure recordings (mm. Hg.) by the arm-cuff method were made before vein ligation and several times during the immediate post-ligation period. This method of measuring arterial pressure is admittedly inaccurate when the venous pressure rise occurs in a matter of seconds.

Lumbar puncture after operation was done in 15 patients. The pressure was measured and fluid drained to reduce it by one-half the increment over normal if an elevation was present.

Symptoms elicited in the postoperative period were recorded and compared to the fluctuation in venous and cerebrospinal fluid pressures. The subjectivity of these data tended to reduce their reliability.

RESULTS

The Queckenstedt test performed on seven patients before operation showed one to be positive. In this patient the positive result was on the side opposite the operative site, and on the operative side the cerebrospinal fluid pressure rose from 230 to 540 mm. In one other patient there was a suggestively positive test on the contralateral side. In two patients the Queckenstedt was performed after unilateral neck dissection had been carried out for eight weeks and two years, respectively, and the operative side in each patient showed a pressure rise, though reduced, on ipsilateral compression as Sugarbaker reported, indicative of the development of collateral circulation. At the time of neck dissection and after jugular ligation, there was an excessive rise in cerebrospinal fluid pressure in these four patients.

Normal internal jugular vein pressures taken by Conner (V. S.) were measured at the jugular bulb. In five unanesthetized adults they varied from 3.0 to 8.3 cm. of sodium citrate. In 32 anesthetized subjects at operation (Table I) the resting jugular vein pressures measured one inch above the clavicle varied from 8.0 to 26 cm. of sodium citrate. The averages were found to be 13 cm. for the right vein (22 patients) and 17 cm. for the left (10 patients). Pressures were again recorded one to two minutes after ligation of the vein proximally, by which time the manometer level had become stationary. The average of the heights reached was 33 cm. on the right, an increment of 21 cm., and 26 cm. on the left side with an increment of 9.0 cm. The extremes of the heights were 14 to 61, and of the increments, 6 to 51.

Arterial blood pressures at operation recorded by the arm-cuff method as mm. Hg. showed no constant change immediately after jugular vein ligation. The pressures in six patients rose from 10 to 25 mm. within one minute of the period of ligation. Both during and after operation the blood pressures were maintained above shock levels. Arterial pressure rises were noted in a few patients during and after operation.
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The cerebrospinal fluid pressure was recorded continuously at operation in six patients by the technic of Sugarbaker (Table I). Large bore malleable silver needles were used for lumbar puncture. In five there was an immediate rise of pressure 

<table>
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<tr>
<th>Table I—Average Internal Jugular Vein Pressure.</th>
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<tbody>
<tr>
<td>Anesthetized Subjects</td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td>Resting</td>
</tr>
<tr>
<td>One minute after ligation</td>
</tr>
<tr>
<td>Increment over resting pressure</td>
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(after a short lag) following ligation of the jugular vein (Table II). In one patient a drop of 24 mm. occurred. The increments varied from 15 to 50. The comparison of the rises to the increment of pressure in the jugular vein showed a spotty correlation. The largest increment of venous pressure was accompanied by the largest increment of cerebrospinal fluid pressure. It should be noted that the resting fluid pressure was also lower in this patient than in the others.

On the day after operation the cerebrospinal fluid pressure was measured at lumbar puncture in 15 patients. The average was 311 mm. and the range from 140 to 525 (Table III). Values below 200 were found in only two patients, and these two had preoperative Queckenstedt tests.

The duration of the cerebrospinal fluid pressure rise after operation was extremely variable. In one patient it remained elevated for 16 days (six lumbar punctures), in two the rise continued for three days, in two for two days and in ten for at least one day (Table IV).

Symptoms of headache occurred in ten patients in the early postoperative period. Eight were associated with postoperative cerebrospinal fluid pressures of 300 or greater and two with low pressures. These latter evidently suffered leakage from needle puncture in the dura. Nausea and vertigo occurred in three patients postoperatively who had greatly elevated pressures. The eight patients who had headache and elevated pressure were afforded temporary relief by drainage of fluid at lumbar puncture.

DISCUSSION

The subject of control of cerebrospinal fluid pressure has been elaborately treated by Becht. The formation of the fluid, its circulation, and the existing physical forces all bear upon the maintenance of intracranial pressure. The formation and circulation of the fluid are assumed to be normal in these patients. The mechanical factors that participate in the maintenance and fluctuations of normal resting cerebrospinal fluid pressure in animals have been listed by Becht and are six in number—cerebral venous pressure, arterial pressure, respiratory action, volume and pressure of fluid in the skull, and action of the vagus nerve. The effect of gravity must be considered in the surgical patient. These forces are at work in a rigid container with the relatively noncompressible brain.

Given basal conditions under which position, respirations and vagal action are normal and stable, one may produce changes in the cerebrospinal fluid pressure by altering the intracerebral venous pressure or the arterial pressure. The arterial pressure is the chief component of the pressure-producing factors and when the cerebral blood supply is shut off, the fluid pressure falls to zero. When the jugular veins and adjacent cervical collaterals are interrupted, the intracerebral pressure rises. This rise may be either reduced or abolished if the arterial supply is proportionately diminished. If cerebrospinal fluid is removed from the canal, the volume and pressure will be reduced.

Because of the multiplicity of factors there is no constancy in their interaction, for there is no certainty that only one force is in operation. These observations have
been confirmed in man to a large extent. Becht emphasizes that continuous recording of arterial pressure must be performed in order to detect the changes which are often too rapid to be measured by spot determinations with the blood pressure cuff.

### Table II.—Relation of Jugular Vein Pressure Increment to C. S. F. Pressure Rise at Operation.

<table>
<thead>
<tr>
<th>J. V. P. Increment (cm. of Na citrate)</th>
<th>C. S. F. Pressure at Operation</th>
<th>Resting</th>
<th>After J. V. Ligation</th>
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<tbody>
<tr>
<td>5</td>
<td>420</td>
<td></td>
<td>450</td>
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<td>9</td>
<td>360</td>
<td></td>
<td>375</td>
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<tr>
<td>12</td>
<td>230</td>
<td></td>
<td>244</td>
</tr>
<tr>
<td>32</td>
<td>190</td>
<td></td>
<td>270</td>
</tr>
<tr>
<td>6) at 2nd</td>
<td>540</td>
<td></td>
<td>570</td>
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<tr>
<td>51) op.</td>
<td>440</td>
<td></td>
<td>416</td>
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Legend: Each horizontal row of figures refers to observations in a single patient.

Venous Pressure. The normal venous pressure in the internal jugular vein at the root of the neck approaches zero and it fluctuates with respiration. The pressure gradient rises as the cranial venous sinuses are approached. It might be assumed that the pressure in the jugular vein would be proportional to the pressure within the cranium. Becht measured pressures simultaneously at the root of the neck and in the torcular Herophili under normal conditions and found that there was no correlation whatsoever, and concluded that jugular vein pressure could not be relied upon as a gauge of intracranial venous pressure. When other conditions are normal, cerebral venous and fluid pressure are about the same.

In the present studies, jugular vein pressures were taken under distinctly abnormal conditions. The patients were all lightly anesthetized by endotracheal technic. Several different anesthetic agents were employed, at times with interchanges during the operation. Efforts to seal off the tube with an inflatable cuff or by packing the oropharynx to obtain a closed airway often resulted in great straining and/or coughing by the patient at frequent intervals. This straining often continued throughout the operation and simulated the reproduction of Valsalva's experiment, an action which is known to raise intracranial pressure. This effect was noted in the patients in whom simultaneous recordings of arterial, venous and cerebrospinal fluid pressures were made. As the operation progressed, all pressures tended to become higher. Although collateral channels begin their adaptation immediately after jugular ligation, the associated mechanical factors incident to operation produced a great though temporary increase both in venous pressure (in the jugular) and in cerebrospinal fluid pressure. These observations in man confirm the experimental ones reported by Becht.

### Table III.—C. S. F. Pressure.

<table>
<thead>
<tr>
<th>First day postop.—Lumbar Puncture</th>
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<tr>
<td>15 patients</td>
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<tr>
<td>Range = 140—525</td>
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<tr>
<td>Average = 311</td>
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</table>

Another factor not previously mentioned may play a part in raising the venous pressure within the cranium, namely, spasm of the veins above the clavicle. It has been observed in many of the patients in this series that after the jugular vein has been ligated, it frequently becomes tightly closed so that if the clamp or ligature be removed from the cranial side, there is no flow of blood. This may exist throughout the remainder of the operation and persist until the vein is ligated a second time at the bulb. The question is raised as to whether there might not be reflex spasm in other non-ligated veins in the neck, especially on the contralateral side, with further temporary blockage of cranial venous outflow.

When both jugular veins are ligated at bilateral radical neck dissection there is no doubt that the great increase in cerebrospinal fluid pressure is directly related to the shutting off of these veins. The suddenness of the production of the block imposes an immediate strain on the collateral channels (which may even go into spasm) which
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Postoperative spinal fluid pressure. In 15 patients who had lumbar puncture after operation, the average of the resting pressure was 311 mm. The figures in two of these patients were below 200, and both of these had had pressures taken at operation through a large bore malleable needle and it is most likely that fluid leaked through the perforation of the dura. That this may be true has been demonstrated by Franksson and Gordh.⁹ In several of these patients there was little or no increase in postligation venous pressure or in cerebrospinal fluid pressure at operation (in those having this test), yet the postoperative spinal fluid pressure was elevated. In one patient the elevation persisted for 16 days. In others, as shown in the table, it persisted for varying lengths of time.

Table V consists of comparisons of the postoperative cerebrospinal fluid pressures with the increments of venous pressure after jugular ligation. It will be seen that there is a slight correlation in that the higher the venous pressure, the higher the pressure at lumbar puncture. The two patients whose venous pressures were over 40 had had previous spinal punctures with large needles and a continual leak of fluid must have ensued, so that we can hypothesize that the pressure must have been higher.

Aids in operative management. Ligation of one or both internal jugular veins may be followed by such a great increase in cerebrospinal fluid pressure that death will occur. A few simple precautions and tests may be used prophylactically to prevent a catastrophe. The preoperative Queckenstedt test will show the response to compression of the neck veins: Although in itself inconclusive, a variation from the expected normal will indicate the need for following the spinal fluid changes at operation. In the case of a bilateral radical neck dissection in one stage, or the second stage of the same operation, a high venous and cerebrospinal fluid pressure will take place. It is necessarily in these patients that lum-
bar puncture be done before operation and continuous recordings of pressure in a manometer be performed. When the pressure rises beyond the desired limit, fluid may be withdrawn and the pressure regulated as needed. There is no known level that must be maintained, but if the pressure rapidly rises, the lowering should be done gradually to prevent compression of the brain stem.

The venous pressure as recorded in the internal jugular vein at operation usually will not be helpful, but when the increment of rise exceeds 30 cm. of sodium citrate, a persistently high cerebrospinal fluid pressure may be expected. It is recommended that this test be performed before jugular ligation is to be done because of the value in the occasional case. Its simplicity and innocuousness are in its favor.

Attempts should be made to keep the arterial pressure from rising. The steady flow of transfused blood to keep pace with loss in the operative field and the prevention of forced breathing and straining by the patient are the most important factors in maintaining an even arterial pressure.

Postoperatively, lumbar puncture to lower the cerebrospinal fluid pressure may be done at any time. Slow emergence from anesthesia and signs of cerebral irritation are the guides to performing lumbar puncture to drain fluid soon after operation. The lumbar puncture may be repeated daily and fluid withdrawn as needed until the pressure has subsided. The symptoms of headache, vertigo, nausea or diplopia are relieved by the withdrawal of fluid, but will recur until the pressure returns to normal limits.

SUMMARY AND CONCLUSIONS

1. A series of 32 patients with 34 radical neck dissections has been presented.
2. Studies of pressure in the internal jugular veins before and after ligation, and the cerebrospinal fluid pressure before, during and after operations were performed.
3. Emphasis is placed on the increased jugular vein and cerebral venous pressure as only one of the mechanical factors in the rise of cerebrospinal fluid pressure.
4. Conditions at operation that participate in raising intracranial pressure have been discussed.
5. The jugular vein pressure increase after ligation is not a true gauge of increased intracranial pressure, but may be suggestive when the increment over the pre-ligation pressure exceeds 30 cm.
6. Cerebrospinal fluid pressure the day after the operation of radical neck dissection was almost universally increased.
7. Measures in the management of patients undergoing radical neck dissection are outlined.

BIBLIOGRAPHY

DISCUSSION.—Dr. ALTON OCHSNER, New Orleans, La.: We certainly should be indebted to Dr. Royster for calling attention to these changes that occur following ligation or excision of the jugular vein. With the increasing incidence of bilateral radical neck dissection, this is becoming even more important. At the present time Dr. Reichard Kahle and Dr. Jean Witz, two men in the Department of Surgery at Tulane, are conducting a comparative experiment in dogs, doing radical bilateral neck dissections, and they have found that if in the normal animal they did a bilateral simultaneous neck dissection, without exception these animals died; they died within 24 hours of markedly increased intracranial tension. If, however, they used a polyethylene shunt after ligation on one side, all though the tube became clogged within a period of six hours, the survival rate was markedly increased and, as a matter of fact, very few of the animals died. So this tremendous increase in venous pressure in the head following removal of both jugular veins is only temporary, and if it does become necessary to do a bilateral resection, which is being increasingly done and which does carry a definite hazard, there is a chance that the patient might be tided over this critical period by using the polyethylene shunt and later removing the tube after it has served its function.

Dr. ELDRIDGE CAMPBELL, Albany, N. Y.: I wish simply to reemphasize one point Dr. Royster made concerning the effect of the anesthesia itself. We have often been dismayed at exposing the dura in a patient to find that the pressure was very high, even if there were no tumor. In recent months we have been measuring the pressure, beginning before the anesthetic was given, and recording it throughout. We have found that in many instances the pressure rises very sharply during induction. Important factors are coughing, straining and vomiting. The startling thing is the height to which it may rise and may remain for some time. In several patients without tumors the spinal blood pressure has exceeded 600 mm. of water, while in those with tumors the pressure has exceeded 900 mm. of water. I think this is an additional factor which is worth bearing in mind.

Dr. Grant E. Ward, Baltimore, Md.: We have had occasion to do a large number of neck dissections in Baltimore during the last few years. I have done only one or two bilateral neck dissec

ions, and most of them have had tremendous swelling of the face following.

I want to thank Dr. Royster for his splendid work and presentation. I have watched him a little bit from a distance, because Dr. Donald Proctor is back with us now and has been telling us about Dr. Royster's observations. We would be much interested to know how much clinical effect the increased intracranial effect has on the patient. We have not seen any bad clinical effects that could be attributed to increased intracranial pressure and I wonder if, following Dr. Royster's statement, it would be well to anticipate such a rise, and whether it would be well to do a spinal puncture and poke a hole in the dura to see if that would not keep the pressure down.

Dr. HENRY P. ROYSTER, Philadelphia, Pa. (closing): With reference to Dr. Ochsner's questions, in the paper by Beck in 1920, which reports work done on dogs, the entire field is covered. He showed that bilateral ligation of the jugulars actually caused an increase in cerebrospinal fluid pressure, but I do not know what type of anesthetic was used. This would also answer Dr. Campbell's question. I think that six hours after the effect of anesthesia has subsided and the patient or animal has emerged, the effect of the shunt described by Dr. Ochsner would not then be so necessary. The venous adaptation that occurs through the vertebral veins does not have a chance to take place because of the associated effects of anesthesia, regardless of the type of drugs used. For instance, the frequent straining under the light anesthesia that is used reproduces Valsalva's experiment, so that with every few breaths the patient may be blocking off veins from the head. This process may continue until emergence, so that I think a shunt or spinal tap would be good during this period. I think the way to tell whether the patient shows any sign of cerebral effect is to tap the spinal canal to observe pressure, or to observe for lucidity, muscular function and quietness during the immediate postoperative period. One patient of ours I think did have increased intracranial pressure, although I cannot prove it; the patient died within 36 hours of operation. That was the beginning of my interest in the problem. We had no studies on that patient that would let us know this was the trouble. He had signs of cerebral irritation and never recovered consciousness.

I wish to thank the discussors for their interest in this paper.
TISSUE REACTIONS TO TANTALUM GAUZE AND STAINLESS STEEL GAUZE: AN EXPERIMENTAL COMPARISON*

Amos R. Koontz, M.D. and Robert C. Kimberly, M.D.

Baltimore, Maryland

From the Departments of Surgery of The Johns Hopkins Hospital and The Johns Hopkins University School of Medicine, Baltimore, Maryland

Prostheses of various sorts have been used for many years to repair tissue defects in various parts of the body. Many types of foreign materials have been used, a great many of which have been introduced in recent years. During the last six and a half years we have been using tantalum gauze in hernias associated with tissue deficiencies. In the meantime, plastics of various sorts have been introduced, and also stainless steel gauze.

While tantalum gauze had given us uniformly excellent results, we realized that it was probably not the "last word"; therefore, in June of 1948, we began experiments on other materials in order to compare the tissue reactions to them with those to tantalum. We felt it necessary to determine experimentally whether any of the other materials on the market were as good or better than tantalum. In our search for other prosthetic gauzes, we became aware of the complexity of available products. There are many "stainless steels" with varying compositions, which produce corresponding degrees of physiological and chemical reactions. Easily confused with these are also alloys containing little or no iron. Our request for stainless steel gauze to compare with tantalum was filled by one of the commercial suppliers with a very fine mesh stainless steel gauze and one designated as Durloy. Our previous report was chiefly concerned with Durloy gauze under the erroneous impression that it was a variety of stainless steel such as had been widely used in surgery. Therefore, in reporting the experiments, we made the mistake of speaking of "Durloy steel mesh," when in reality the Durloy metal is not steel at all. Only after completion of the paper was the composition of Durloy made available to us—it is 67 per cent nickel, 30 per cent copper, 1.4 per cent iron, 1 per cent manganese, plus small percentages of unimportant elements. Had we known that there was so little iron in the metal, we would not have used it in our experiments. At any rate, we showed that Durloy (a monel metal) is unsuitable for surgical use. Our experience also emphasizes the dangers that may arise if surgeons merely ask for "stainless steel" without giving clear specifications of the type and composition desired.

In our experiments the Durloy gauze became surrounded with dense scar tissue which did not infiltrate the metallic mesh and which produced a hard, tumor-like effect. In similar sites in the same animals, tantalum gauze healed promptly, producing a normal fibroblastic reaction and a soft pliable wound.

Since these experiments were reported we have succeeded in getting stainless steel gauze (type 304) in which the size of the mesh and the size of the wire in the mesh is exactly the same as that in the

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* Read before the meeting of the Southern Surgical Association at Hollywood, Florida, on December 11, 1952.
KOONTZ AND KIMBERLY

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Tantalum gauze commercially in use in recent years. The mesh is 50 x 50 mesh (50 strands to the inch in each direction) and the wire is 3 mil wire (0.003 inches in diameter).* Stainless steel of types 302 and 316 are also used in surgery. Type 316 is a frequently used type, and it is said to be better because of the small amount of molybdenum contained in it. Otherwise it differs very little from either type 302 or type 304. So far as we know no stainless steel guaze is made from type 316 stainless steel. The composition of the three types of stainless steel mentioned is as follows:

<table>
<thead>
<tr>
<th>Chemical Analysis</th>
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<tr>
<td>Percent</td>
</tr>
<tr>
<td>Type</td>
</tr>
<tr>
<td>302...</td>
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<tr>
<td>304...</td>
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<tr>
<td>316...</td>
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Comparative Amount of Fibrosis Produced by Implantation of Tantalum Gauze and Stainless Steel Gauze. Experiments were conducted in 76 dogs in an effort to determine which of these two types of gauzes was better for the surgical cure of hernias associated with tissue deficiencies. Approximately two inches of the rectus sheath and muscle on each side were resected through separate right and left rectus incisions in each of these animals. The defect on the right side was repaired by suturing in a piece of tantalum gauze, using one black silk suture in each corner of the gauze. On the left side the defect was repaired by similarly suturing in a piece of stainless steel gauze. On each side the subcutaneous tissue was closed with fine black silk, interrupted, and the skin with fine black silk, continuous. These animals were sacrificed at periods of time after operation varying from one week to 33 weeks. Table I shows the results of these experiments.

When the animals were sacrificed, the site of each implantation was carefully explored not only for the amount of fibrosis, but for the readiness with which the piece of implanted gauze could be pulled away from surrounding tissues. We found, as reported in former experiments, that in almost every instance it was impossible to pull the tantalum gauze away from the surrounding tissues. We also found that in the great majority of cases the tissues could be fairly readily pulled away from the stainless steel gauze in spite of the fact that fibroblasts had grown readily through the meshes of the gauze. Furthermore, the amount of fibrosis around the tantalum was greater than that around the stainless steel. While neither of these metals caused unfavorable tissue reactions, the difference between the amount of fibrosis occurring around them was fairly striking. This still leaves the question, which has been posed in previous articles, as to whether tantalum does not actually stimulate the growth of fibroblasts. We had hoped to resolve this question by tissue culture experiments, but so far have been unable to do it.

It might be said that in interpreting the results of the early experiments of this

* The type 304 stainless steel gauze was furnished us by Davis & Geck, Inc., and is marketed by them under the trade name of Surgaloy Mesh. The tantalum gauze used in the experiments was furnished by the Ethicon Suture Laboratories.
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We do not believe that our methods were as critical as those used in the later experiments, in that we did not use as careful tests to determine whether or not the tissues could be pulled away from the implanted pieces of gauze. Were we to autopsy the early cases again, the table might not now show a better infiltration in two instances on the stainless steel side, and equal infiltration on the two sides in 20 of the cases.

Comparative Reactions of Tantalum Gauze and Stainless Steel Gauze to Infection. We believe it has been pretty well established that neither tantalum nor stainless steel cause a great deal of trouble in the presence of infection. Neither is extruded from infected wounds unless other foreign bodies are present. Neither causes persistent sinus tracts unless other foreign bodies are present, and likewise buried persistent granulomas are rare in the presence of these metals unless there are other complicating factors present. In spite of this, we thought it would be well to compare the tissue reactions to tantalum gauze and stainless steel gauze in wounds which were purposely infected. To this end 27 experiments were carried out. The operations in these experiments were performed exactly as in the series of 76 animals reported above, except that no silk or other non-absorbable material was used in the wounds other than the tantalum gauze on one side and stainless steel gauze on the other. Catgut was used to suture the materials in place, as ligatures, and to close the subcutaneous tissue. However, the animals were all operated upon in an entirely non-sterile fashion. Their bellies were simply clipped and not shaved. The skin was not cleansed or prepared in any way whatsoever. Non-sterile instruments, gowns, and gloves were used and these were purposely further contaminated by exposing them to the surfaces of laboratory tables and the laboratory floor. The operators did not wear caps or

### Table 1

<table>
<thead>
<tr>
<th>Cases of infection</th>
<th>Tantalum side</th>
<th>Stainless steel side</th>
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<tbody>
<tr>
<td>Total No. of Cases</td>
<td>Fibrosis better on tantalum side</td>
<td>Fibrosis better on stainless steel side</td>
</tr>
<tr>
<td>76</td>
<td>53</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
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It should be pointed out also that in some of the early experiments which are not included in the table, we implanted only stainless steel. The fibrosis was not as dense as that we were accustomed to seeing when tantalum was implanted. We felt that it would be unfair to compare instances of tantalum implanted in one dog and stainless steel in another. We therefore adopted the plan of implanting both metals in the same dog so as to eliminate any possibility of individual differences in tissue reactions in different animals. Figure 1 shows characteristic reactions in three of the experiments here reported.

While all of the experiments reported above were done under aseptic conditions, infection did occur in a certain number of the wounds as shown in the table. It is well known that both tantalum and stainless steel cause little trouble in the presence of infection. In this series of experiments infection occurred five times on the tantalum side and seven times on the stainless steel side. It is not believed, however, that this small difference is of statistical significance.
masks. The results of these experiments are shown in Table II.

While these wounds were all infected and suppurred to start with, the infection cleared up in varying lengths of time and good healing took place without sinus formation. In a few cases there were persistent buried granulomas, but it is felt that these would probably have cleared up spontaneously had the animals been allowed to go longer before death and autopsy. The average length of time between operation and autopsy was approximately two months. As shown in the table, there were two cases of persistent infection still remaining on the tantalum side at the time of autopsy and four cases on the stainless steel side. Here again it is not believed that this difference is sufficient to be of statistical value.

In spite of the fact that all of the wounds in this series of experiments were infected, excellent infiltration of fibrous tissue took place and the wounds healed nicely. The final result was just as strong as if no infection had taken place, with the possible exception of those few cases in which there were buried granulomas adjacent to the implanted gauze. These granulomas possibly caused slight weakness at that particular site, but certainly not much. Furthermore, it is believed that these granulomas would have cleared up had the animals been allowed to live long enough. The table does show, though, that the fibroblastic reaction was greater on the tantalum side in 22 cases, and equal on the two sides in four cases.

**Experiments of Others.** Narat and Khedroo did some experimental work on tantalum gauze of exactly the same type as that used in the experiments reported here. They found that the gauze became thoroughly infiltrated with fibrous tissue and it was very difficult to remove from the surrounding tissues. They also did some experiments on stainless steel gauze. However, the type of stainless steel gauze they used was a little different from that used in the experiments here reported. It was

<table>
<thead>
<tr>
<th>Cases of persistent infection</th>
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</thead>
<tbody>
<tr>
<td>Total No. of Cases</td>
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<tr>
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</tr>
<tr>
<td>27</td>
</tr>
</tbody>
</table>

80 x 80 mesh and made up of wire 0.0055 inches in diameter. It was, however, made from the same type of stainless steel as that used in our experiments. They found that after implantation of this material the stainless steel gauze became enclosed in a thick bursa-like envelope formed by proliferating connective tissue, without marked penetration of the meshes by fibroblasts, and that the steel gauze could be easily removed from the site of implantation. They further state that leucocytic reaction was much more marked around the stainless steel gauze than around the tantalum gauze, and that any purulent inflammation persisted longer about stainless steel than about tantalum or fortisan fabric. These experiments show more differences in tissue reactions between gauzes made from the two materials than ours do. Is it possible that these differences occur

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* A letter from F. P. Smith Wire & Iron Works, 2340 Clybourn Avenue, Chicago 14, Illinois, dated September 29, 1952, informs us that the stainless steel gauze furnished Narat and Khedroo was made from Type 304 stainless steel.
TISSUE REACTIONS TO TANTALUM GAUZE

from the fact that Narat and Khedroo did not use gauzes of the two materials which were made with the same size mesh and wire? It hardly seems probable, as there was so little difference.

The Breaking Point of Metallic Gauze on Repeated Bendings. Much has been said about the "fragmentation" of tantalum gauze after implantation in the body. Roentgenograms of patients, made within a few weeks after operations in which tantalum gauze has been implanted, show the mesh to be perfectly smooth with little if any wrinkling. Roentgenograms made a few months later will show some wrinkling of the gauze and, at the end of the year, there is evidence of considerable wrinkling. After a further period of time (not exactly determined) there occur some breaks in the gauze. Recently reports have been coming to us from various sources in different parts of the country to the effect that tantalum gauze is outmoded and should no longer be used because of the "fragmentation" of the mesh which occurs after a year or two, or after a longer period of time. Such statements reveal an ignorance of the function of the material.

The material has not been used by us, and should not be used by anyone, as a means of curing a hernia per se. Tantalum gauze simply acts as a framework for the ingrowth of fibrous tissue. Fibrous tissue grows through all of the meshes of the gauze and completely surrounds it, forming an unusually heavy bed of new fibrous tissue. If eventually some cracks do occur in the gauze, it makes no difference, since by that time the fibrous tissue infiltrating and surrounding the gauze has so strengthened the abdominal wall that it would matter little whether the gauze were present or not. Its function has long ago been fulfilled as a trelliswork for the ingrowth of fibrous tissue.

We have seen no instance in which any trouble was caused by breaks occurring in tantalum gauze except in one instance. In this case a tall, very slender man with a large incisional hernia between the xyphoid and the umbilicus had been operated upon by another surgeon who had implanted a large piece of tantalum gauze. His hernia was cured, but a year and a half after his operation he lost considerable weight, and all efforts to make him gain weight had failed. The tantalum gauze could be felt through the skin, which had practically no subcutaneous tissue under it, and the impression made on the skin by wrinkles in the gauze could also be seen. Finally some cracking took place in the gauze and the ends of the fine wires protruded through the skin, making patterns in the skin corresponding with the wrinkles in the implanted gauze where the cracks had taken place.
The protruding parts of the cracked gauze were removed by one of us (A. R. K.) and the wounds promptly healed.

Another interesting case, operated upon by one of us (A. R. K.) and previously reported, was that of a four-year-old child who had complete absence of the upper part of the abdominal wall except for skin and peritoneum. There was no subcutaneous tissue and no preperitoneal tissue. In spite of this, an implantation of tantalum gauze was made and the child has been well ever since (four and one half years) without suffering any inconvenience whatsoever.

In general, though, it is desirable, as previously pointed out, to cover tantalum gauze with skin that has plenty of subcutaneous tissue under it. However, this is not always possible. One very thin woman, operated upon by one of us (A. R. K.) four years ago has been well ever since in spite of the fact that the implanted tantalum gauze can be readily felt through the skin, and the pattern of it on the skin is readily visible. The patient has no discomfort from this. There are several other cases which come in the same category.

Various claims have been made about the amount of bending which both tantalum and stainless steel will stand before breaking. We did a few experiments in an effort to determine this. The results of these experiments are shown in Table III. It will readily be seen that in these experiments the stainless steel gauze resisted bending slightly better than tantalum gauze. The footnote shows contrary results. Throckmorton, moreover, did bending experiments on tantalum and stainless steel wire with just the opposite results. In his experiments, using 3 mil (0.003 inch) wire, he found that it took twice as many bendings to break tantalum wire as it did stainless steel wire. In larger caliber wires, it also required more bendings to break tantalum wire than stainless steel, but the larger the caliber of the wire, the less bendings it took to break the wire of either metal. Babcock reports that strips of 165 mesh, 0.0019 inch stainless steel cloth have been flexed back and forth over three one and one-half inch bendings. Throckmorton, moreover, did bending experiments on tantalum and stainless steel wire with just the opposite results. In his experiments, using 3 mil (0.003 inch) wire, he found that it took twice as many bendings to break tantalum wire as it did stainless steel wire. In larger caliber wires, it also required more bendings to break tantalum wire than stainless steel, but the larger the caliber of the wire, the less bendings it took to break the wire of either metal. Babcock reports that strips of 165 mesh, 0.0019 inch stainless steel cloth have been flexed back and forth over three one and one-half inch bendings.

* The Fansteel Metallurgical Corporation of North Chicago, Illinois, have done some bending experiments on both tantalum gauze and stainless steel gauze of exactly the same type and made by the same people as those we used in our experiments. They have been kind enough to allow us to give their results here. They used a much more accurate machine than we used, but also bent their pieces of gauze through 180°.

Their results were as follows:

Complete 180° cycles endured Range Average
Tantalum gauze 320–390 360
Stainless steel gauze 117–224 157

The comparative physical properties of tantalum and stainless steel are given below. The figures for the tantalum were taken from a monograph entitled "Tantalum" published by the Fansteel Metallurgical Corporation in 1935. Those for stainless steel were obtained from the "Handbook of Stainless Steel" published by the Armco Steel Corporation, of Middletown, Ohio, in 1952.

**Tantalum**

Tensile strength—130,000 lbs. per square inch

<table>
<thead>
<tr>
<th>Property</th>
<th>Tantalum</th>
<th>Stainless Steel Type 302</th>
<th>Stainless Steel Type 316</th>
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<td>Brinell hardness</td>
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<td>180</td>
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<td>Melting point</td>
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**Stainless Steel Type 302**

Tensile strength—100,000 lbs. per square inch

<table>
<thead>
<tr>
<th>Property</th>
<th>Tantalum</th>
<th>Stainless Steel Type 302</th>
<th>Stainless Steel Type 316</th>
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<tr>
<td>Brinell hardness</td>
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<td>180</td>
<td>180</td>
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<td>Melting point</td>
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<td>Young's modulus</td>
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<td>28,000,000 lbs. per square inch</td>
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<td>7.93</td>
<td>7.98</td>
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<td>Magnetic permeability</td>
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</table>

**Stainless Steel Type 316**

Tensile strength—100,000 lbs. per square inch

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<th>Property</th>
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<th>Stainless Steel Type 302</th>
<th>Stainless Steel Type 316</th>
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<tr>
<td>Brinell hardness</td>
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<td>180</td>
<td>180</td>
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<td>Melting point</td>
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<td>2600° C</td>
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<tr>
<td>Young's modulus</td>
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<td>28,000,000 lbs. per square inch</td>
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<td>Magnetic permeability</td>
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<td>less than 1.02</td>
<td>less than 1.02</td>
</tr>
</tbody>
</table>
rollers in an arc of 180 degrees over 18,000,000 times without any the wires breaking. I have seen no confirmation of these remarkable figures. Certainly our experiments and those of Throckmorton and others are in marked contrast. There does, however, seem to be considerable individual variation in the breaking point of different samples of both tantalum and stainless steel. Possibly this has been due to differ-
ences in the way the experiments were conducted.

We make no claim that our experiments were conducted with any remarkable degree of scientific accuracy. We do believe, however, that both tantalum and stainless steel wire will break if bent often enough, and we further believe that there is evidence to show that there is no remarkable difference between the breaking point of wires of the same size made from the two different metals.

Cutting Sutures “On the Knot.” For years it has been the practice of most surgeons to cut silk sutures “on the knot.” This practice has carried over into wire sutures. We are convinced that this practice will often lead to faulty results. Price has shown that knots (of cotton, silk, and stainless steel wire) do come untied. They are especially apt to come untied if they are cut on the knot. He advocates cutting the ends two or more millimeters long. Stone had four cases roentgen rayed several months after the structures sutured together remaining in apposition until firm healing has taken place.

Preparation of Metallic Gauzes for Operation. A film of grease on any gauze is not conducive to the ingrowth of fibroblasts. Metallic gauzes should be prepared by scrubbing with soap and water, rinsing thoroughly, and then sponging off with ether or alcohol. Only then are they ready for the autoclave.

COMMENT

We believe that these experiments show that tantalum gauze has at least some advantage over stainless steel gauze in hernia repair. There is more fibrosis through and around tantalum gauze than is the case with stainless steel gauze, and the tissues are much more readily pulled away from stainless steel gauze than from tantalum gauze. As a matter of fact it is practically impossible to pull tissues away from tantalum gauze, so firmly are they intermingled with
KOONTZ AND KIMBERLY

This may have far-reaching results when these materials are used in repair of those hernias which have poor tissues and large defects, the edges of which cannot be approximated.

It is interesting to speculate on the reasons for more fibrosis in the case of tantalum gauze than in stainless steel gauze. So dense is the fibrosis around tantalum gauze that we have reason to believe that the tantalum may actually stimulate fibrosis while possibly stainless steel does not. This we have not been able to prove.

Some consideration also might be given to the fact that tantalum gauze is all made from one element, while stainless steel is an alloy composed of several elements. Could it be that there is some electrolytic action between the various elements of the stainless steel alloy, or between possibly dissimilar areas in the alloy, which might cause some unfavorable reaction in the surrounding tissues and thus prevent as dense a fibrosis around stainless steel as that which occurs around tantalum?

Whether the difference demonstrated experimentally will result in great differences in clinical results can only be determined by extensive clinical trials.

**SUMMARY**

Implanted tantalum gauze causes a more favorable fibroblastic tissue response than does implanted stainless steel gauze. Just how great the difference is, it is difficult to determine. Difficult hernias in which these two types of gauze are apt to be used are hard to cure. If there is any slight advantage of tantalum gauze over stainless steel gauze, we believe that in the interest of the patient the former should be used in spite of the fact that it is somewhat more expensive than the latter. The added cost of tantalum is a small fraction of the overall cost of the operation and convalescence, to say nothing of re-operation, should that be necessary.

**BIBLIOGRAPHY**


**DISCUSSION.—Dr. R. C. KIMBERLY, Baltimore, Md.:** I appreciate the opportunity of speaking before the Association. In connection with the fragmentation of the gauze, we have conducted some experiments on bending the mesh to determine how well it would withstand bending. Babcock reports that he was able to bend strips of stainless steel mesh over 3.5 inch rollers more than 18 million times without breaking, and Throckmorton reported that, using 3 mil wire, the tantalum withstood bending twice as well as stainless steel.

In our experiments we took mesh of various widths and placed it in an ordinary bench vise and then bent the mesh through 180°. The bending was all done by one operator so we tried to control the experiment as best we could. On the average, with tantalum, the first break appeared in the mesh after 60 bendings, and with stainless steel the first break occurred after 119 bendings; the final break appeared after 301 bendings of tantalum, and 344 with stainless steel.

We obtained the physical characteristics of the two metals from the manufacturers and they are practically identical. The density of tantalum is about twice that of stainless steel, but the tensile strength, the hardness, melting point, coefficient...
expansion and magnetic permeability are practically identical.

Dr. William H. Phooleau, Charleston, S. C.: I rise to ask one question, but I shall take advantage of being here to comment upon the advisability of leaving the ends long in knots made with stainless steel wire. In thin people, even though the ends are turned over so as to prevent their having a sharp point, they may be painful and even erode through the skin. On several occasions I have had to remove them. For the past several years I have used three flat throws and cut the ends flush with the knot. Though I have not checked specifically by x-ray examination, I have not been aware of trouble arising from knots becoming untied. The foregoing remarks apply to the use of 32 gauge monofilament alloy steel wire. I find this more satisfactory than the braided type.

I would like Dr. Koontz to comment further upon the method of removing tantalum mesh. I have had two patients, both definitely neurotics, in whom the question arose as to the desirability of removing tantalum mesh used in the repair of inguinal hernia. In these cases apparently there was nothing to be gained except from a psychic standpoint. It was my impression that the wire strands are firmly imbedded in fibrous tissue and are often fractured, so that their removal would be difficult and likely jeopardize the hernia repair.

Dr. Frederick E. Kreidel, Charleston, S. C.: Dr. Koontz asked me to present briefly the usefulness of tantalum mesh in controlling certain other types of herniation, namely, of the central nervous system.

(Slide) The first case is a very extensive myelomeningocele where the primary repair was unsuccessful with recurrence of a huge herniation in the lumbosacral canal. At a secondary operation tantalum mesh was used and laid across the defect.

(Slide) Again there was failure of healing of the surface; but it granulated in and finally healed over and remains well today.

Dr. Koontz asked me to tell about some of the work we are doing at Johns Hopkins Hospital which was started by Dr. Milton Edgerton of the plastic department. We have been doing some rather radical operations about the pharynx and esophagus, and have had trouble in some cases in replacing lost mucosa. The interesting thing about these operations in connection with tantalum is that tantalum has been used as a vehicle to carry skin, and it treats the skin very nicely. The lateral pharyngeal wall has been reconstructed by suturing a split graft of skin to tantalum with the raw surface out and sewing the combination to the inside of the pharynx with silk, leaving the silk sutures long and tying them over a gauze stent of iodoform gauze soaked in balsam of Peru. In about seven to ten days the stent is removed and, if the tantalum mesh is loose, it is removed at that time or maybe later. That makes it possible to graft the inside of a large flap of skin to line the inside of the pharyngeal wall.

Dr. Edgerton has had about six cases, I think, in whom the upper end of the esophagus and lower part of the pharynx was removed. Reconstruction at the time of operation was carried out by making a tantalum cone, the larger end being attached to the hypopharynx and the lower end to the esophagus. The cone is surrounded by a split graft, raw surface out, and is left in place for a variable

Tissue Reactions to Tantalum Gauze
KOONTZ AND KIMBERLY

I had done the eighth operation on an inguinal hernia. The last five operations on this man were done by a man who wrote a book on hernia. At one of these five operations he put in a piece of tantalum gauze and at the next operation he removed it—why, I do not know.

I had one patient, the fattest woman I have ever seen, with a panniculus six inches deep and just like soft butter. Following operation, due to the impairment of circulation incident to the wide dissection of skin flaps, an area of necrosis developed in the abdominal wall about two inches in diameter. The necrotic area was cut away with scissors. This left an opening two inches in diameter which was just like a well drilled through the deep fat. One could look down the well and see the exposed tantalum gauze at the bottom of it. I tried to close the opening but it was just like sewing on butter. After a time, on looking down that well again, one could see granulations growing up through the tantalum, and the wound gradually closed over by second intention. I have had other similar cases.

I would like to speak about Dr. Vance’s case. I have had similar cases. One patient was sent me by another surgeon who had operated upon her more than a year previously. The wound became infected and had been draining for more than a year. The hernia, however, was entirely cured and the abdominal wall was firm. I injected the sinus tract with methylene blue and it spread out subcutaneously all over the abdominal wall. I then opened the wound and took out scores of cotton sutures and ligatures, which were easy to find because of the staining with methylene blue. Following this the wound healed promptly. In such cases it is not necessary to take out the tantalum gauze but only the foreign bodies which are causing the infection to persist. It is to be remembered that tantalum will resist infection, but that silk and cotton do not. I feel sure that if Dr. Vance will follow the plan I used in the case just mentioned, and will take out all the offending silk sutures, the wound will heal promptly. The tantalum may be left in place.

As to cutis grafts, I think they unquestionably have a place in hernia repair, and there may be many other things that have a place. I have never claimed that tantalum gauze was the “last word.” However, it is a very useful material in difficult hernias. I have had excellent results in a limited experience with cutis grafts. However, in several large ventral hernias I have put in a piece of tantalum gauze 12 x 12 inches. It would be difficult to get enough skin to cover such a large area. Besides, the use of tantalum eliminates the necessity of preparing the graft.

I wish to thank all the discussors very much.

Dr. Amos R. Koontz, Baltimore, Md. (closing): Dr. Prioleau asked about cutting on the knots in thin people. When one does not cut on the knots, it is easy enough to turn the ends of the wires under so they will not come through the skin. I have used this material in a number of thin people and have not had any wires come through the skin. I can see, though, how they might do so sometimes.

As to removal of the gauze after hernia repair, I have never had to do this. However, I operated on a man just about two weeks ago who had had seven previous operations on the same inguinal hernia. I have operated on several who had had six previous operations, but this was the first time

length of time; the first one I think he left in place for several months. General anesthesia may be required to take out the tantalum mesh from the reformed new esophagus. These people get along well and swallow nicely.

I should like to make one further comment; you see by Dr. Kredel’s discussion and this discussion that tantalum mesh has gradually arisen from the abdomen to the head.

Dr. Hugh A. Bailey, Charleston, W. Va.: I feel more or less hesitant in discussing this paper, and am doing so chiefly because of my great admiration and respect for Dr. Koontz. Another reason is that he mentioned something about cutis graft, a subject which we have discussed on numerous occasions. I might be deviating just a trifle, although I hope I am not, but we were able to take quite a large amount of cutis. We became interested because of the work of Dr. John E. Cannaday, who I believe is one of the foremost men in this country in developing this particular procedure. You can use any type of dermatone, or a Blair-Brown knife, or an electrical one, or one that is hand-worked, to lift the epidermis and, after the cutis is taken, the epidermis is replaced as a skin graft to cover the donor site. If the graft is not large enough one can take two grafts from one or both legs or from other suitable areas, and suture them together. We have not had any particular trouble in finding enough cutis to repair these massive hernias. On the other hand, there is no question but that tantalum wire offers one of the best procedures in this type of surgery.

I certainly agree with Dr. Koontz that there should not be a cut on the knot. Not that we know much about the field, but we use this wire and cut it fairly long, and if we think it is a little too long, we push the ends of the suture downward with the hope that they will not penetrate the skin and cause discomfort.

I certainly enjoyed this presentation very much.

FIFTY YEARS AGO

In 1911, Dr. Amos R. Koontz was practicing in Baltimore, Md.
In this paper are presented the 15-year to 40-year survival rates following radical mastectomy performed at the Mayo Clinic for carcinoma of the mammary gland in females.

I have studied the results obtained from radical mastectomy for carcinoma of the breast for a number of years and have been interested in determining certain factors which influence the prognosis as shown by the survival rates following operation. These studies have shown that the prognosis of carcinoma of the breast following radical mastectomy is related to many different factors, some of the more important of which are (1) the extent of the malignant involvement at the time of operation, (2) the degree of malignancy as shown by microscopic examination of the primary lesion, (3) the presence of other associated conditions such as pregnancy and lactation, (4) the general constitutional diseases such as diabetes, and (5) the age of the patient.

Statistical studies that I have made of the results of radical surgical treatment of all patients divided into these different groups show that the prognosis is improved or decreased by these factors, the most important of which is the extent of the disease at the time of operation as indicated by the presence or absence of axillary nodal metastasis found microscopically at the time of operation.

These studies show that the prognosis is more favorable in patients in whom the axillary lymph nodes are not involved by a metastatic malignant growth than in those in whom the axillary nodes were found to be involved at the time of the operation.

Studies made according to the grade of the primary lesion showed that the higher the grade of malignancy the less favorable the prognosis, and those according to age of the patient showed that the prognosis was better in older patients, especially those with high grade lesions, than in the younger period of life. In those patients with associated conditions such as pregnancy and lactation, as well as in those patients with constitutional diseases such as diabetes, the prognosis was more serious.

Some of these factors which influence prognosis can be evaluated in studying the primary lesion and others by the clinical and surgical findings. However, I believe that these studies are of value only in a study of large groups of cases and are of little value in determining the prognosis in an individual case. As has been shown in these group studies in which the radical mastectomy has been of the same type, and in which all of the factors which influence prognosis, such as age of patient, grade of malignancy and, as far as can be determined, extent of the disease, are as similar as possible, some of these patients will sur-
vive only a few years and others will survive many years after operation.

These findings indicate that an important factor in prognosis may be present in the normal tissues of the body. There is no method of determining or evaluating this property of the normal tissues of the body which may be termed tissue resistance to malignant disease. I believe that the body tissues contain local tissue resistance which inhibits the extension of the primary growth locally in the breast as well as a general resistance which inhibits metastatic cell growth in distant parts of the body.

The hypothesis of local tissue resistance to malignant growth could explain why in some patients who present a malignant growth in the breast which the patient states has been present for a long period of time, the malignant growth is found at the time of operation to be of high grade, but fairly well circumscribed and with no demonstrable axillary metastasis, a condition which indicates good resistance in the surrounding normal tissue to malignant disease. In other patients with the same type of malignant growth, the tumor may have been present for even a shorter period of time but the lesion may be found to be diffuse throughout a large part of the breast and extensive axillary nodal metastasis may be found at the time of operation, a condition which indicates poor local and general tissue resistance to malignant disease.

Decreased tissue resistance could account for the poor prognosis shown by patients who have carcinoma of the breast and also diabetes, as well as the occurrence of carcinoma of the breast in several members of one family who may inherit this tendency. The poor prognosis in carcinoma of the breast occurring during pregnancy and lactation indicates poor normal tissue resistance as well as stimulated cell growth due to hormonal activity accompanying pregnancy.

There are unavoidable inaccuracies in statistical studies because of the difficulty in obtaining accurate classifications of cases owing to the many factors that influence prognosis. However, when carefully carried out, these studies are the most accurate method we have of determining the results obtained from radical surgical treatment of malignant disease of the breast.

<table>
<thead>
<tr>
<th>Table I.—Unilateral Carcinoma of the Breast (Females) Survival Rates 15 to 40 Years Following Radical Mastectomy.</th>
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<tbody>
<tr>
<td>Survival Rates 15 to 40 Years Following Radical Mastectomy</td>
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<td>Years p.o.</td>
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</tr>
<tr>
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<tr>
<td>20 or more</td>
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<td>25 or more</td>
</tr>
<tr>
<td>30 or more</td>
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<td>35 to 40...</td>
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*Based on traced patients. Inquiry as of January 1, 1950.
RADICAL MASTECTOMY FOR CANCER OF THE BREAST

...markably high percentage of traced patients. In all the statistical studies of survival rates it has been assumed that deaths of patients have been due to malignant disease, although in many instances it was definitely known that death was due to other causes.

TABLE II.—Unilateral Carcinoma of the Breast (Females) With and Without Nodal Metastasis: Survival Rates 15 to 40 Years Following Radical Mastectomy.*

<table>
<thead>
<tr>
<th>Years p. o.</th>
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<th>Total Traced No. %</th>
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<tr>
<td>15 or more</td>
<td>2,953 2,918 351 12.0</td>
<td>1,684 1,645 793 48.2</td>
</tr>
<tr>
<td>20 or more</td>
<td>2,336 2,302 172 7.3</td>
<td>1,279 1,242 452 36.4</td>
</tr>
<tr>
<td>25 or more</td>
<td>1,560 1,538 73 4.7</td>
<td>879 853 228 26.7</td>
</tr>
<tr>
<td>35 or more</td>
<td>898 884 34 3.8</td>
<td>517 491 94 19.1</td>
</tr>
<tr>
<td>45 or more</td>
<td>304 300 6 2.0</td>
<td>216 207 29 14.0</td>
</tr>
</tbody>
</table>

*Based on traced patients. Inquiry as of January 1, 1950.

The study of survival rates was compiled on inquiry made January 1, 1950, which permits the compiling of the survival rates in the different year periods from 15 to 40 years. These studies have been made primarily to determine long term survival rates following radical mastectomy.

This study of survival rates for the various periods after operation was made in the following manner. All women treated by radical mastectomy, regardless of the type or extent of their disease or other associated conditions, were included in this study. The records of patients who had undergone operation the requisite number of years prior to the time of inquiry (January 1, 1950) were selected first. For the calculation of the 15-year survival rate, the patients who had undergone operation in 1934 or earlier were selected; for the 20-year survival rate, those who had undergone operation in 1929 or earlier were selected; for the 25-year survival rate, those who had undergone operation in 1924 or earlier were selected, and so forth. Obviously, then, the 15-year survival rate was calculated on a larger number of patients than the 20-year survival rate; the 20-year survival rate on a larger number of patients than the 25-year survival rate, and so forth. Any patient not traced for a sufficient number of years after operation was considered untraced, and was not included in the calculation of the survival rate.

When patients did not answer the routine follow-up letter, the local department of health, bureau of vital statistics, or other agencies were consulted to learn whether any record of death existed.

The first tabulation of survival rates was to determine the number and percentage of traced patients who had lived 15 to 40 years following radical mastectomy. The results are shown in Table I.
The cases represented in this study comprise, for the calculation of the 15-year survival rates, 4,637 patients with unilateral carcinoma of the breast on whom radical mastectomy was performed in 1934 or earlier, of whom 4,563 (98.4 per cent) were traced. Of patients traced for the respective numbers of years, as explained in an earlier paragraph, 1,144 (25.1 per cent) survived 15 or more years, 624 (17.6 per cent) survived 20 or more years, 301 (12.6 per cent) survived 25 or more years, 128 (9.3 per cent) survived 30 or more years and 35 (6.9 per cent) survived 35 to 40 years.

A second tabulation of survival rates was made to determine the influence that axillary nodal metastasis, when found at the time of operation, had on the prognosis. The results are shown in Table II. Of the 4,563 traced patients, 2,918 (63.9 per cent) were found to have axillary nodal metastasis at the time of operation and 1,645 (36.1 per cent) did not reveal nodal metastasis. Of the 2,918 who had axillary nodal metastasis, 351 (12.0 per cent) lived 15 or more years, and of the 1,645 without axillary nodal metastasis, 793 (48.2 per cent) lived 15 or more years. The table gives the 15, 20, 25, 30 and 35 year survival rates for patients with and without axillary nodal metastasis.

### Table IV.—Unilateral Carcinoma of the Breast (Females) Without Axillary Nodal Metastasis: Living 35 or More Years After Radical Mastectomy.

<table>
<thead>
<tr>
<th>Age at operation, yr.</th>
<th>No.</th>
<th>Pathologic diagnosis</th>
<th>Years after operation (Last report 1950)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>35</td>
</tr>
<tr>
<td>29</td>
<td>1</td>
<td>Adenocarcinoma: not graded (1)</td>
<td>1</td>
</tr>
<tr>
<td>30-39</td>
<td>5</td>
<td>Adenocarcinoma: not graded (3)</td>
<td>1</td>
</tr>
<tr>
<td>40-45</td>
<td>9</td>
<td>Adenocarcinoma: not graded (3); gr. 2 (1); gr. 3 (2); gr. 4 (3)</td>
<td>8</td>
</tr>
<tr>
<td>46-49</td>
<td>8</td>
<td>Adenocarcinoma: not graded (2); gr. 2 (2); gr. 4 (1)</td>
<td>1</td>
</tr>
<tr>
<td>51</td>
<td>1</td>
<td>Adenocarcinoma: gr. 3 (1)</td>
<td>8</td>
</tr>
</tbody>
</table>

*21 above are living and 8 died beyond 35 years—total 29.*

### Table V.—Unilateral Carcinoma of the Breast (Females) Without Axillary Nodal Metastasis: Died 35 or More Years After Radical Mastectomy.

<table>
<thead>
<tr>
<th>Date of operation</th>
<th>Age, yr.</th>
<th>Pathologic diagnosis</th>
<th>Date of death</th>
<th>Yr. p. o.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-30-11</td>
<td>51</td>
<td>Adenocarcinoma</td>
<td>7-10-49</td>
<td>38</td>
</tr>
<tr>
<td>2-13-12</td>
<td>45</td>
<td>Adenocarcinoma</td>
<td>10-10-48</td>
<td>38</td>
</tr>
<tr>
<td>2-15-11</td>
<td>34</td>
<td>Adenocarcinoma</td>
<td>12-27-48</td>
<td>37</td>
</tr>
<tr>
<td>12-2-12</td>
<td>51</td>
<td>Adenocarcinoma, gr. 3</td>
<td>4-20-50</td>
<td>37</td>
</tr>
<tr>
<td>3-18-13</td>
<td>48</td>
<td>Adenocarcinoma</td>
<td>8-8-50</td>
<td>37</td>
</tr>
<tr>
<td>4-29-12</td>
<td>35</td>
<td>Adenocarcinoma, gr. 3</td>
<td>1-1-48</td>
<td>35</td>
</tr>
<tr>
<td>5-6-12</td>
<td>52</td>
<td>Adenocarcinoma</td>
<td>2-1-48</td>
<td>35</td>
</tr>
<tr>
<td>10-21-13</td>
<td>38</td>
<td>Adenocarcinoma</td>
<td>10-24-48</td>
<td>35</td>
</tr>
</tbody>
</table>

Total—8 (8 above died and 21 are living beyond 35 years; total 29).

There is considerable difference in the survival rates in the year periods both in the cases with and without nodal metastasis. The prognosis was much better in those cases in which axillary nodal metastasis was not found at the time of operation than it was in those cases in which nodal metastasis was found. While the percentage of cases gradually decreases in all of the year periods, it is very gratifying to know that even in the 35 to 40 year period following radical mastectomy, 6 (2.0 per cent) of 300 traced patients who had axillary nodal metastasis lived 35 or more years and 29 (14.0 per cent) of the 207 traced patients...
without axillary nodal metastasis lived 35 or more years after the operation.

A study was then made of the 35 patients who survived 35 or more years after radical mastectomy. The age of the patient, the pathologic diagnosis and the length of survival of the six patients with nodal metastasis are shown in Table III and reveal that four of these patients were still living at the time of the last inquiry in 1950, 36 and 38 years after operation. Two patients had died 35 years after operation.

Tables IV and V give the ages of the 29 patients in whom no nodal metastasis was found at the time of the operation, the grades of malignancy of those graded and the survival rates.

Table IV shows that 21 of the 29 patients were still living 35 to 40 years following operation. The age varies from 29 to 51 years at the time of the operation. Eleven of the lesions were not graded and ten showed grades 2, 3 and 4. Eight patients survived 35 years, three survived 36 years, five survived 37 years, three survived 38 years, and two survived 40 years after radical mastectomy.

Table V shows the eight patients who were dead at the time of the inquiry in 1950 but had lived 35 or more years following the radical mastectomy. Three patients lived 35 years, three lived 37 years and two lived 38 years after operation.

Although axillary nodal metastasis is only one of the factors that may indicate the extent of the disease at the time of operation, I believe that it is one of the most important factors indicating the prognosis following operation because of the great influence that it has on the survival rates.
Table VI shows that of the 4,753 patients who underwent radical mastectomy for unilateral carcinoma of the breast prior to 1934, 116 (2.44 per cent) underwent subsequent radical mastectomy at the clinic for carcinoma of the remaining breast. Of the 116 patients who underwent bilateral nonsimultaneous mastectomy for carcinoma of the breast, 96 had the second operation 15 or more years prior to inquiry in 1950. Of these 96 patients, 93 were traced. Of these 93 patients, 18 (19.4 per cent) lived 15 or more years following the second operation and nine (15.8 per cent) of the 57 traced patients lived 20 or more years following the second operation.

A study was then made of the 40 patients who lived 15 or more years following the first radical mastectomy for carcinoma of the breast and later developed a carcinoma in the remaining breast for which a radical mastectomy was performed, to determine the number and percentage with and without axillary nodal metastasis at the time of the first operation.

Table VII shows that 13 (32.5 per cent) of the 40 patients who lived 15 or more years after the first operation had axillary nodal metastasis and 27 (67.5 per cent) did not have nodal metastasis at the time of the first operation. Nine (45.0 per cent) of the 20 patients who lived 20 or more years had nodal metastasis and 11 (55.0 per cent) did not have nodal metastasis at the time of the first operation.

Of the 116 patients (Table VIII) who had bilateral nonsimultaneous mastectomy for carcinoma of the breast, 96 had the second operation after 2nd operation.
RADICAL MASTECTOMY FOR CANCER OF THE BREAST

first and the second operation, seven (38.9 per cent) had axillary nodal metastasis. Three of these seven were found to have axillary nodal metastasis at the time of both operations, three had axillary nodal metastasis at the time of the first operation and no axillary metastasis was found at the second operation, and in the remaining one case, axillary nodal metastasis was found at the time of the second operation, but none was found at the time of the first operation.

In 11 (61.1 per cent) of the 18 patients who lived 15 or more years following both the first and the second operation, no axillary nodal metastasis was found at the time of either operation.

Of the nine patients who lived 20 or more years following both first and second radical mastectomies, three (33.3 per cent) had axillary nodal metastasis. Of these three patients, two had axillary nodal metastasis at the time of both operations and in one axillary nodal metastasis was found at the time of the first operation only. Six (66.7 per cent) of the nine patients who survived 20 or more years following both operations did not have axillary nodal metastasis at either operation.

It is difficult if not impossible, on the basis of present knowledge, to explain the satisfactory results obtained following bilateral radical mastectomy for bilateral non-simultaneous carcinoma. In some respects the results are more satisfactory than those obtained in unilateral carcinoma of the breast. This is particularly difficult to explain in patients presenting axillary nodal metastasis at the time of both operations and indicates that an important factor in the prognosis in these patients is that they have an increased resistance to malignant disease. This may also explain the very sat-

satisfactory results obtained from radical mastectomy in patients with unilateral carcinoma of the breast with axillary nodal metastasis who survive 35 or more years following the operation.

The actual occurrence of carcinoma in the remaining breast is higher than in the percentage shown in these studies which comprises only those patients who have had both operations at the clinic, since many patients had either the original or second radical mastectomy elsewhere. The latter patients are not included, since we do not have definite knowledge as to the type of lesion they presented at the operation elsewhere. The relative frequency of carcinoma occurring in the remaining breast in any patient who presents unilateral carcinoma of the breast, indicates the advisability of considering mastectomy of the remaining breast as a prophylactic procedure. However, it is very important and gratifying to know that carcinoma occurring in the remaining breast is not hopeless, that patients should be given the benefit of a radical mastectomy if the lesion in the remaining breast is within operable limits and that they may obtain a very satisfactory result from this operation on the second lesion.

These studies on long term survival rates following radical mastectomy for carcinoma of the breast show that it is impossible to determine definitely the prognosis in an individual case either before or at the time of the operation, and that patients with unilateral high grade malignant growths with metastasis as well as those patients who develop a malignant growth in the remaining breast with metastasis subsequently, may survive many years following operation.
A SUBAXILLARY INCISION FOR RADICAL MASTECTOMY*

WILLIAM F. MACFEE, M.D.

NEW YORK, N. Y.

Since the original descriptions of radical mastectomy by Halsted17 and Meyer17 in the same year (1894), various modifications of the operation have been offered. A number of these have pertained to the skin incision. The reason for modification, as a rule, has been either to permit easier access to the operative field or to facilitate closure of the wound. In some instances, the objective has been a less conspicuous scar. The better known incisions1-20 are outlined diagrammatically in Figures 1A and 1B. Some of the incisions shown are still widely employed, but others are mainly of historic interest.

The incision which is being offered for your consideration has been used since May, 1930, in more than 125 cases, with results that have been satisfactory from a surgical point of view, and gratifying to the patient.

The primary purpose of the subaxillary incision was the provision of a more acceptable scar for the woman who has had the misfortune to lose her breast. It was recognized that such an incision must not compromise the thoroughness of the operation or make its performance significantly more difficult. The only real difference between the subaxillary incision and certain others in common use is that the subaxillary incision is carried under the axilla and out onto the posteromedial aspect of the arm instead of being placed above the axilla and extended out on the anterior surface of the arm. The scar of the subaxillary incision is in a relatively concealed position and permits the patient to dress as other women do and even to appear in an ordinary bathing suit.

The subaxillary incision, when completed, is essentially an ellipse encompassing the breast with the upper angle curved posteriorly across the lower axilla and extended along the posteromedial aspect of the arm.

The medial portion of the incision is outlined first. It is begun near the tip of the xyphoid cartilage and carried upward along the medial border of the breast to the level of the inferior boundary of the axilla, where it crosses the posterior margin of the pectoralis major muscle. It is then directed transversely backward across the lower border of the axilla, slightly below the axillary hair line, and extended along the posteromedial aspect of the arm for a distance of five to eight centimeters.

The starting point of the lateral component of the ellipse is the same as that of the medial incision. The lateral incision is first carried laterally and upward, then in a slightly medial direction to include the breast. As it approaches the medial incision above, it is curved sharply in a lateral direction to form an acute angle with the medial incision (Fig. 2).

The skin margins are undercut in the usual manner to form medial and lateral flaps. Complete exposure is obtained, as shown in Figure 3. Removal of the breast and pectoral muscles and dissection of the axilla are then conducted according to the operator’s preference. The wound is closed.

The principal advantages of the incision are:

1. The scar is placed in a relatively concealed position permitting the patient a wider range of sports and social activity without fear of revealing her surgical history (Figs. 6A and 6B). The scar furthermore permits full range of motion (Fig. 7).

2. The incision permits complete exposure of the operative field and imposes no restrictions on the extent of the operation.

Fig. 1A.—Incisions for radical mastectomy with names of originators and dates.
3. It is applicable to carcinoma in any part of the breast.
4. The actual performance of the radical operation is not complicated by the incision.
5. Closure of the wound, either with or without skin grafting, is not more difficult than with other incisions of comparable extent.
6. Sloughing of skin edges is uncommon if excessive tension is avoided.
7. Subsequent swelling of the arm has been slight as a rule.

The disadvantages of the incision are few:

1. Elevation of the axillary part of the medial flap is slightly more difficult than uncovering the axillary contents from above.
2. The medial flap is wider with the subaxillary incision than with an incision placed above the axilla, and dissection under the flap is correspondingly more difficult. Dissection under the lateral flap, however, is made easier by the subaxillary incision.

SUMMARY

A subaxillary incision for radical mastectomy is presented. It differs from some of
A SUBAXILLARY INCISION FOR RADICAL MASTECTOMY

Fig. 2
Fig. 2.—Outline of subaxillary incision described in the text.

Fig. 3
Fig. 3.—Flaps dissected up and operative field exposed. Insert shows wound closed.

Fig. 4
Fig. 4.—Subaxillary incision completely closed by primary suture at end of operation.

Fig. 5
Fig. 5.—Subaxillary incision closed with aid of skin graft. Donor site is seen below and lateral to grafted area. The grafted area becomes a relatively fixed point and arm should be fully abducted while skin edges about the area to be grafted are being sutured to the chest wall and the graft applied. Fixation of graft by suture is important.

The incision affords complete exposure of the operative field and in no way limits the extent of the operation.

The resulting scar occupies a relatively concealed position and imposes little or no restriction of the patient's activities or wearing apparel.

BIBLIOGRAPHY


Fig. 6.—(A) Scar of subaxillary incision four months after operation. (B) The same scar as it appears with arm at the side.

Fig. 7.—A subaxillary scar seven years after operation. Abduction is natural and easy.


A SUBAXILLARY INCISION FOR RADICAL MASTECTOMY


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SURGICAL EXPERIENCE WITH MAMMARY CANCER
GROWTH CHARACTERISTICS OBSERVED DURING THE TREATMENT OF 258 PRIVATE PATIENTS WITH BREAST CANCER*

JOHN V. GOODE, M.D. AND JAMES A. MARTIN, M.D.

DALLAS, TEXAS

FROM THE DEPARTMENT OF SURGERY, SOUTHWESTERN MEDICAL SCHOOL OF THE UNIVERSITY OF TEXAS, AND THE GASTON HOSPITAL, DALLAS, TEXAS

CARCINOMA OF THE breast is an exceedingly treacherous form of cancer because its course is so very unpredictable. Daland has followed 100 untreated breast cancer patients for ten years and found that 22 per cent were alive five years after apparent onset of the disease. This would indicate that the tumor kills slowly; however, at times breast cancer grows and spreads with the rapidity of an infection. Such rapid growth of the tumor may come at the onset of the disease or may develop in a tumor whose growth has been imperceptible for years. In addition, there is abundant evidence that a breast cancer may at any time in its life history grow into a blood vessel and then be spread by the blood stream. For these reasons it is impossible to predict the course that a very small and presumably early breast cancer may take.

Private patients were chosen for this study because it was felt that their records were more complete, their disease diagnosed earlier, that they enjoyed better nutrition and, in general, they should show the best side of the problem. It is realized that the use of private patients entails a considerable degree of favorable selection of material, and therefore our survival results are not comparable to those obtained in large charity clinics, where natural selection is more likely to be unfavorable.

Uniformity in treatment was obtained by having all operations done by one surgeon (J. V. G.) and all roentgen ray therapy by one radiological clinic. Survival statistics are absolute in that every patient examined or treated is included. There were 12 patients who were considered surgically incurable. These patients were seen only one time and were referred elsewhere for palliative treatment but are included as dead in computing survival rates. There were 38 patients who received definitive treatment elsewhere but were followed by the authors. Such records are used only where they serve to emphasize some point, such as the frequency of bilateral cancer or the danger of wound infection, but are not used in computing survival figures. In dealing with bilateral cancer, when the authors treated both cancers they were counted as two cases and each followed separately; if the authors treated only one of the bilateral cancers, only this one was used for computing survival rate after operation (Table I).

With increasing knowledge of cancer both by the medical profession and the lay public, the problem of diagnosing early breast cancer is becoming more difficult. This is particularly true when the cancer is very small. The old teaching that cancer produces a painless lump in the breast holds for the most part. In this series 112 patients (56 per cent) just happened to find

a painless lump, but 88 (44 per cent) stated their attention was drawn to the lump by one or more of the following symptoms: pain, burning, tenderness to pressure, shooting pains, ulceration, drawing, itching, numbness, or rarely, discharge from the nipple. Since 44 per cent of our patients with cancer noticed some abnormal sensation that drew their attention to the tumor, it is obviously an error to consider benign lesions painful and malignant ones insensitive.

Any lump developing in the breast of a woman after the menopause, especially in the very aged woman, must be considered cancer until proven otherwise—this regardless of the physical findings. In the very old patient the growth of a cancer may be extremely rapid without producing puckering, but tending to present a visible tumefaction that feels elastic rather than stony hard. The apparently rapid growth and the rubbery feel are usually brought about by central necrosis of the tumor. Also, occasionally a small deep cancer contracts Cooper's ligaments without causing atrophy of the intervening fat. This results in a lobular puffy swelling just under the skin, giving every appearance of a superficial lipoma and defying accurate diagnosis until the mass is excised and sectioned, revealing a small cancer in its center.

At times examination of the sectioned tumor and of the frozen sections will not be conclusive. Of 130 biopsy examinations, there were seven (5.4 per cent) which were either erroneous or inconclusive. Four positive specimens were considered negative and two negative specimens were first called positive. There was one where the pathologist stated he was unable to make a positive diagnosis on frozen section. Such a report is far more helpful than even a very learned guess. When the surgeon and the pathologist are in doubt about the diagnosis, it is far wiser to close the wound and wait for permanent sections than to carry out a simple mastectomy, because simple mastectomy seems a little more radical than excision of the tumor alone. That such a procedure is a safe one is shown by the fact that excision of the tumor and waiting 24 to 48 hours for permanent section was not followed by any demonstrable change in five-year survival rate, provided the biopsy wound was not infected. There were, however, two patients sent to us with infected biopsy wounds, and these did very badly. It seemed that the incompletely removed cancer cells were able to find their way into the widely open lymphatics and blood vessels of the infected closed wound. These two patients died promptly with extreme involvement of the skin of the chest wall, forming cancer en cuirasse.

The operative treatment of 220 patients accepted for treatment has been about the same as that usually employed by other surgeons. Whenever possible a transverse incision with an extension upward from the midportion forming an inverted T was the incision employed. A small skin graft was used whenever primary closure would result in a dangerously tight closure. Such grafting (Figure 1.) was necessary in about one out of four operations (48 of 209 radical mastectomies). There were no operative deaths in this series and no axillary recurrences. In general, when the lymph nodes were found histologically to be invaded by tumor cells, we advised postoperative roentgen ray therapy (73 patients); when the lymph nodes were not involved or when the patient’s condition was precarious, this therapy was not advised (136 patients). Simple mastectomy was carried out for treatment of the breast cancer in 15 instances. Ten patients were considered too debilitated to permit the radical operation; three had the breast removed as a palliative procedure, and two underwent simple mastectomy because there was an error in pathological diagnosis.
We had great hopes that the addition of postoperative roentgen ray therapy to the radical operation would result in a sizable increase in the number of five-year survivors when compared to a group receiving radical mastectomy but no roentgen ray therapy. Our figures do not show this to be the case. Of 63 patients treated five or more years previously whose axillary nodes showed cancer invasion, there were 34 who received roentgen ray therapy in addition to the radical operation, and 29 similar patients who received no roentgen ray therapy; 14 of the former and 11 of the latter group lived five or more years after operation. This indicates that in those with positive nodes where we had used roentgen ray therapy most often and had expected the most from it, no significant improvement in survival rate could be attributed to it. There were 71 patients treated five or more years previously whose axillary lymph nodes were negative for tumor invasion by histological examination. Fifty-eight of these patients received no roentgen ray therapy and 47 of them lived five or more years; ten received preoperative roentgen ray therapy and seven of them lived over five years. There were three patients with negative nodes who received postoperative roentgen ray and all three lived five or more years.

Histologic grading of breast tumors for determining the prognosis in any given case has been disappointing. The division of tumors into stages as suggested by Portmann has seemed to be the best means of studying the problem of prognosis. Grouped in Stage I are patients whose tumors are limited to the breast; Stage II patients show extension of the tumor process to a few of the axillary lymph nodes; Stage III is more advanced, with practically all of the axillary nodes being invaded and the tumor fixed to pectoral fascia or skin, with or without extensive edema or ulceration locally. Stage IV cases show clinically or by roentgen ray examination evidence of distant metastasis of the disease. Using the above classification for the study of 145 patients seen five or more years previously, there were alive at the end of five years after operation 83 patients of the 145 seen five or more years previously. This gives an absolute five-year survival rate of 57.2 per cent (Table II).

A still better estimate of prognosis can be made if the length of time that the cancer has been present can be obtained. In spite of the feeling by some that this time element is not important, our study

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**TABLE I—Entire Breast Cancer Experience.**

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
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<tbody>
<tr>
<td>270</td>
<td>Patients with cancer.</td>
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<tr>
<td>-12</td>
<td>Surgically incurable. No surgical therapy given.</td>
</tr>
<tr>
<td>258</td>
<td>Patients seen more than one time.</td>
</tr>
<tr>
<td>-38</td>
<td>Patients treated originally by other doctors.</td>
</tr>
<tr>
<td>220</td>
<td>Patients treated by us.</td>
</tr>
<tr>
<td>+6</td>
<td>Bilateral cancers both treated by us.</td>
</tr>
<tr>
<td>226</td>
<td>Breast cancers treated by us.</td>
</tr>
<tr>
<td>145</td>
<td>Patients seen five or more years previously; therefore available for survival study. This figure includes the incurable patients.</td>
</tr>
</tbody>
</table>

---

**TABLE II—Relation of Stage of Disease to Survival (Including every patient first seen 5 or more years ago)**

<table>
<thead>
<tr>
<th>Stage</th>
<th>No. Pts. followed up</th>
<th>No. Pts. alive after 5 yrs.</th>
<th>Percent. alive up 5 yrs.</th>
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<tbody>
<tr>
<td>I</td>
<td>68</td>
<td>46.9</td>
<td>1</td>
</tr>
<tr>
<td>II</td>
<td>48</td>
<td>33.1</td>
<td>1</td>
</tr>
<tr>
<td>III</td>
<td>17</td>
<td>11.7</td>
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</tr>
<tr>
<td>IV</td>
<td>12</td>
<td>8.3</td>
<td>5</td>
</tr>
<tr>
<td>TOTAL</td>
<td>145</td>
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<td>83</td>
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seems to show that it is very important. It is quite true that some cases are already in Stage II or III, and probably IV, early in the course of the disease as determined by the history. It is also true that some patients had known of the presence of the tumor for over a year and yet when examined, the cancer was found to be in Stage I. However, immediate treatment yields 76 per cent five-year survivors, whereas delay of over one year in receiving treatment was followed by only 54.7 per cent five-year survivors (Table III). The relatively favorable showing of the long delay group can be accounted for by the fact that included in this group are the most favorable cases of all—the patients who have had the cancer a long time and yet the tumor is still confined to the breast. Also delay in receiving treatment appears to be extremely important, because of 60 patients who had known of their disease less than one month, only three, or five per cent, were in Stage III, whereas of the 62 patients who had known of the cancer over one year, there were 21, or 33.8 per cent, in Stage III. This would indicate that the longer the disease exists the greater the number of less favorable Stage III cases will be found. As is to be expected, the longer the disease exists the greater the opportunity for lymph and blood vessel invasion to take place. Only in the most benign types is time unimportant.

There are many aspects of this problem other than those of the cancerous breast itself. When one considers that the remaining breast after breast amputation for cancer has the same inheritance as the removed breast, and is constantly affected by the same hormones as was its fellow, there is small wonder that this remaining breast is often the source of further difficulty. Ten per cent of our 270 patients were found to have benign lesions of the breasts, either before or after the radical operation. There were 15 instances (5.5 per cent) of bilateral cancer, of which four were considered extensions from the incompletely removed first breast tumor, and 11 were considered new cancers. Of the 15, only four could be considered as terminal episodes of the disease. A review of these bilateral breast cancers reveals the fact that while there was often a long interval of time between the first and the development of the second cancer, the disease moved rapidly after the second cancer had developed. There was only one patient living five or more years after the operation for the second cancer. Of the 15 bilateral cancers, seven are dead and two of the eight surviving patients are living with the disease unchecked. This extremely poor outlook for the remaining breast makes us feel that it is a dangerous organ and that it should be removed if it shows any lesion whatsoever, or even if it becomes uncomfortable. We have removed the remaining breast for seven patients, all of whom have expressed satisfaction with the procedure.

In this series there have not been enough instances of pregnancy complicating breast cancer to draw any conclusions concerning its effect upon the disease. Only two women noticed the breast lump while lactating: one (Grade 3, Stage II) was known to be
alive with persistent cancer after eight years, the other (Grade 2, Stage III) is alive apparently free of disease after four years, in spite of having had three pregnancies since the operation. A third patient (Grade 1, Stage I) is apparently free of the disease seven years after her operation in spite of three pregnancies, and a fourth (Grade 3, Stage I) has no demonstrable cancer five years postoperatively and four years after a therapeutic abortion. These women were all warned that pregnancy was dangerous, and all were advised not to nurse their babies; especially the female babies. Generalities cannot be drawn from these few cases. One can only say that in these few instances pregnancy subsequent to removal of a breast cancer has not seemed to alter the course of the disease.

While there is no evidence that roentgen ray therapy given in the immediate postoperative period adds to survival time, there is abundant evidence that roentgen ray therapy given for palliation of persistent mammary cancer is very worthwhile. The importance of palliation is shown by the fact that in this series there were 209 radical operations, at least 60 of which were followed at some time by reappearance of the tumor. This means that about 29 per cent of our operative cases were candidates for palliative treatment at some time during their lives. As palliative treatment, we have used roentgen ray therapy for bone and brain lesions, low-intensity radium needles for deep chest wall lesions and positive cervical lymph nodes, and surgical excision rarely for skin metastases and movable ulcerating lesions. There are three patients who received one or more such forms of treatment living nine, ten, and 11 years after recurrence, or after they had been considered surgically incurable. More important than these rare cases of long survival are the many cases of persistent and metastatic breast cancer where roentgen ray therapy may have added nothing in terms of survival time, but has added materially to the comfort of the patients during their remaining months of life. Roentgen ray therapy given to the ovaries produces a roentgen ray castration, which may also help in younger women. This has been the only hormonal therapy we have encouraged.

There are two warnings that should be given in this regard. If a lesion appears to be surgically incurable before roentgen ray therapy is given, it usually will be found to be surgically incurable no matter how much better it seems to become during or soon after the roentgen ray treatments. This does not mean that operation should never be employed for such cases, but rather that when it is employed, a most guarded prognosis should be given. It has been our experience that even if roentgen ray therapy

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**Table III.—Relation of Duration of Disease to Its Clinical State and to Five Year Survival.**

<table>
<thead>
<tr>
<th>Lump known to be present</th>
<th>Number of Cases</th>
<th>Stage I</th>
<th>Stage II</th>
<th>Stage III</th>
<th>Stage IV</th>
<th>5+ Year Survivals (120 cases)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1 mo.</td>
<td>60</td>
<td>62</td>
<td>32</td>
<td>5</td>
<td>19</td>
<td>25 = 76%</td>
</tr>
<tr>
<td>1-6 mo.</td>
<td>46</td>
<td>54</td>
<td>41</td>
<td>4</td>
<td>19</td>
<td>28 = 66%</td>
</tr>
<tr>
<td>6 mo.-1 yr.</td>
<td>40</td>
<td>55</td>
<td>33</td>
<td>10</td>
<td>16</td>
<td>25 = 64%</td>
</tr>
<tr>
<td>1+ years</td>
<td>62</td>
<td>45</td>
<td>21</td>
<td>34</td>
<td>23</td>
<td>42 = 55%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>208</td>
<td>54</td>
<td>31</td>
<td>14</td>
<td>2(1%)</td>
<td>77 of 120 = 64%</td>
</tr>
</tbody>
</table>

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**Table IV.—Presumable Route of Metastasis After Radical Mastectomy* (60 patients)**

<table>
<thead>
<tr>
<th>First Evidence of Persistent Breast Cancer</th>
<th>Lymphatic Spread</th>
<th>Hematogenous Spread</th>
</tr>
</thead>
<tbody>
<tr>
<td>area</td>
<td>Bones..</td>
<td>Bones..</td>
</tr>
<tr>
<td>Chest wall, pleura</td>
<td>Lungs..</td>
<td>Lungs..</td>
</tr>
<tr>
<td>mediastinum</td>
<td>Distant soft parts..</td>
<td>Distant soft parts..</td>
</tr>
<tr>
<td>Cervical nodes</td>
<td>Liver..</td>
<td>Liver..</td>
</tr>
<tr>
<td>Other breast</td>
<td>Brain..</td>
<td>Brain..</td>
</tr>
<tr>
<td>TOTAL</td>
<td>TOTAL..</td>
<td>TOTAL..</td>
</tr>
</tbody>
</table>

*This chart was formed using only those records that left little doubt as to the location of the earliest metastasis or first evidence of persistent cancer.

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860
seems to convert a fixed tumor to a movable one, there will be found at operation invasion of the axillary veins or chest wall. Worse yet, when such an operation is incomplete, the residual cancer seems to grow more rapidly than it had been growing before the operation.

**COMPARISON OF TREATED AND UNTREATED BREAST CANCER**

![Graph showing survival rates](image)

**Fig. 2.—Survival of 146 treated patients with cancer of the breast after apparent onset of the disease. The curve is formed by plotting the deaths by months of survival.**

A second suggestion concerns the roentgen ray treatment of bone metastases. It is far wiser to treat the painful area, even though roentgen ray examination fails to show any evidence of bone involvement, than to wait until the diagnostic roentgen rays confirm the impression that there is metastatic cancer in the painful bone.

There were 146 patients we treated whose cancer, as far as we could ascertain, had originated five or more years before this study. Of these, 94 patients were alive and 52 patients dead at the end of five years from the onset of their disease. Two additional patients could not be followed, but are considered to be dead in the determination of the absolute five-year survival figure (63.5 per cent) for treated cancer of the breast. The 52 deaths occurring within five years after onset of the disease are plotted in Figure 2, each dot representing a death. This allows a comparison of our data on treated breast cancer with Daland's data on untreated breast cancer. Five years after apparent onset of the cancer, 22 per cent of the untreated patients and 63.5 per cent of the treated patients were still alive. Half of the untreated patients were dead in two and a half years, whereas after five years more than half of the treated group were still alive.

Although the value of surgical treatment for breast cancer appears obvious from the preceding observations, it is our opinion that in certain instances operative manipulation or incomplete removal of a tumor causes it to grow much more rapidly than it had been growing previously. For this reason we feel that whenever an operation to remove a cancer fails to improve a patient, it makes his condition worse. The damage may be caused by squeezing viable cancer cells into intact lymphatics or blood vessels at the time of operation, or by the growth of incompletely removed cancer into the newly formed, delicate vessels found in the granulation tissue of the healing wound.

It was felt that a study of the first evidence of failure of the radical operation might throw some light on this problem. Cases were grouped according to whether the first evidence of recurrence came as a result of the tumor’s invasion of lymphatic vessels or blood vessels. We are quite aware that late in the disease all patients with breast cancer probably develop blood vessel invasion by the tumor and die as a result of distant and not local spread of the cancer, but what we are concerned with here is the incidence of blood vessel invasion early in the course of the disease as evidenced by the first recognizable metastasis after the operation. The records were not complete enough to give the desired information in every one of the 209 radical mastectomies;
however, in 60 instances we could form a
definite opinion as to the first evidence of
persistence of the growth.

We consider metastases to lung, bone,
liver, brain, and some distant soft parts as
blood borne; and those to the operative
scar, deep chest wall, lymph nodes of the
neck or mediastinum and, rarely, extension
to the opposite breast as lymphatic borne.

Using such a plan the blood borne metas-
tases outnumbered the lymph borne metas-
tases three to one, there being 43 of the
former to 17 of the latter (Table IV). The
clinical significance of this information is
evident. A more thorough radical mastec-
tomy might have helped some of the 17 pa-
tients who showed metastases via the
lymphatics, but it is doubtful that the clas-
sical radical mastectomy could have pre-
vented the metastases in the 43 patients
whose first evidence of metastatic disease
was blood borne. In them the blood vessels
were invaded either before the operation
took place, during the operation, or more
likely after the operation as a result of
spread from supraclavicular or parasternal
lymph nodes which were not removed by
the classical radical mastectomy.

Dahl-Iversen1 has studied this problem of
occult supraclavicular and parasternal
lymph node metastases and reports that
when the axillary lymph nodes are invaded
by tumor, the supraclavicular lymph nodes
will also be found to be invaded in 33 per
cent, and the parasternal lymph nodes in 24
per cent of the operable cases. These fig-
ures seem unusually high in view of the
fact that we encountered supraclavicular
metastases in only four of our 73 patients
whose axillary lymph nodes were positive,
and deep chest wall metastases in only six
instances. Nevertheless, these supraclavic-
ular and parasternal lymph nodes are ex-
tremely important and may remain very
small while the tumor grows through them
into lymph channels and thence to the
blood vessels and lungs. The tissues of two

of our patients showed blood vessel invasion
at the time of the radical operation. One of
these women had a radical mastectomy
elsewhere 18 months before our radical
mastectomy, at which time a nodule found
in the axilla proved to be a blood vessel
filled with growing cancer cells (Fig. 3).

Fig. 3.—The above tissue was removed from
the axilla of a woman who developed cancer in
the right breast 18 months after radical mastectomy
for cancer of the left breast. The axillary lymph
nodes in this patient were not invaded by the
tumor.

The axillary lymph nodes in this patient
were not invaded by the tumor. The other
patient was operated upon presumably for
a Stage II breast cancer and found to have
an axillary blood vessel filled with tumor.
The vessel was situated near one of the
invaded lymph nodes. This second patient
died within 18 months with extensive brain,
liver, and bone metastases. Both of these
women in all likelihood were in Stage IV at
the time of our operation. Their useless
operations might have been spared had we
explored the parasternal area for tumor in-
vaded parasternal lymph nodes in order to
determine whether or not the patient could
be cured surgically. Such a procedure
would possibly prevent a useless operation,
but could add little to the number of pa-
tients cured.

CONCLUSIONS

Since roentgen ray therapy can alter
breast cancer cells greatly even if it does not
destroy them (except in very large doses), and since it is possible that cancer cells can be spread at the time of operation, we are now again employing preoperative roentgen ray therapy to the breast, directing the rays tangentially at the tumor and avoiding the lung. This procedure is followed in two weeks by radical mastectomy, at which time low-intensity radium needles are placed in the upper four intercostal spaces parasternally and also supraclavicularly. In addition these same areas are given deep roentgen ray therapy just as we have treated squamous cell lymph node metastases in the neck. Such a procedure would seem to utilize the best features of the radical operation, namely, the removal of the tumor, and the sterilization of the axilla. It also takes advantage of the best features of radiation therapy, in the delivery of cancer inhibiting roentgen rays to the tumor preoperatively, and the delivery of both cancercidal and lymphatic sclerosing gamma rays of radium postoperatively to the supraclavicular and parasternal lymph nodes, where surgical extirpation of the disease would be most difficult, if not impossible.

BIBLIOGRAPHY

DISCUSSION.—DR. HENRY P. ROYSTER, Philadelphia, Pa.: I would like to ask Dr. Goode a question on a point which I am sure he omitted for lack of time; that is, the dosage that is needed. Speaking from the point of view of our radiology colleagues, we should have a target to shoot at in the form of nodes, and have to know the dosage to apply.

DR. JOHN V. GOODE, Dallas, Texas (closing): The needles that we have used are those that Dr. C. L. Martin of Dallas has described and used for years in the treatment of squamous cell cancer invading cervical lymph nodes. They are low intensity radium needles containing 0.6 to 0.8 mg. of radium per cm. of active length and having a 0.5 mm. platinum filtration. These needles are allowed to remain in place for seven days. I did not describe the technic of their insertion in detail because we have carried out the procedure only three times and are in the process of developing the technic. What I hoped to do was to present our present method of extending the attack to the parasternal and supraclavicular lymph nodes in the treatment of carcinoma of the breast.
CERTAIN PREVENTABLE ERRORS IN THE DIAGNOSIS AND MANAGEMENT OF CARCINOMA OF THE STOMACH AND THE LUNG*

FREDERICK FITZHERBERT BOYCE, M.D.

NEW ORLEANS, LOUISIANA

FROM THE DEPARTMENT OF SURGERY, TULANE UNIVERSITY OF LOUISIANA SCHOOL OF MEDICINE, NEW ORLEANS

Elsewhere I have reported in some detail the statistical data of two recent studies of malignant disease at Charity Hospital of Louisiana at New Orleans. One of these studies concerns 200 surgical cases of carcinoma of the stomach and is the third such analysis I have made from this institution. The other concerns 186 fatalities from carcinoma of the lung, in only 55 of which any sort of surgery was done. Little in these studies furnishes legitimate grounds for optimism, and certain trends evident in both furnish, it seems to me, legitimate grounds for anxiety. I should like to discuss these trends briefly, although the proper forum before which such remarks should be made is not an organization of surgeons.

To my mind the most hopeful aspect of both these series was the clearcut tendency to extend the indications of radical, extirpative surgery to the borderline cases in which, not too long ago, no surgery, or only palliative surgery, would have been done. In many instances the radical operation was itself palliative, but such surgery should not be regarded as futile because it does not produce a lasting cure. On the contrary, it is fully justified because, as Churchill said in a discussion of carcinoma of the lung, "it makes the best terms possible with a disease that is already hopeless."


DELAY BY PATIENTS

Both series of cases illustrate again the unhappy and paradoxical situation, about which nothing at all can be done in the light of present knowledge, that the shorter the duration of symptoms in both diseases, the shorter also is the duration of life after their onset. In both series, however, many patients signed their own death warrants by their delay in seeking medical advice. What makes that fact even more disturbing is that in carcinoma of the stomach the duration of symptoms before medical consultation was actually somewhat longer in the 1952 series than in the similar series studied in 1933 and in 1941. This is not a local problem. Harvey and his associates at the Presbyterian Hospital in New York, Welch and Allen at the Massachusetts General Hospital in Boston, and Jemerin at Mount Sinai Hospital in New York have had the same experience.

Some of the patients who delayed seeking medical advice simply ignored their symptoms. Others treated themselves with the various remedies advertised over the radio for acid indigestion and for respiratory symptoms, including, in both series, hadacol, which was then at its pinnacle of popularity. Something is evidently wrong with our extensive and expensive campaigns of public education about cancer when their necessarily somber presentations of facts are thus drowned out. Specific investigations, such as that conducted by Harms,
Plaut and Oughterson in 1943, suggest that most patients hospitalized for cancer are not impressed by them if indeed they hear them or read them at all.

DELAY BY PHYSICIANS

Even if we disclaim responsibility for what the patient does or does not do before he comes under the care of a physician, the profession cannot so readily exonerate itself from blame for what happens next. A little more than a third of the patients with carcinoma of the lung who finally reached Charity Hospital, and a little more than half of the patients with carcinoma of the stomach, had not neglected their own interests. They had consulted physicians. Sometimes they had consulted two or more physicians. Sometimes they had consulted them almost as soon as they had realized that they were ill. What happened to them is depressing. Only 10 of the 69 patients with carcinoma of the lung who sought medical advice before hospitalization, and only 16 of the 101 patients with carcinoma of the stomach, were promptly referred to the hospital. The remainder were treated for various periods of time, by various incorrect methods, sometimes for as long as two years.

Patients with carcinoma of the stomach were treated by belladonna, antacids and diets for their digestive symptoms, sometimes on the diagnosis of ulcer, sometimes on no diagnosis at all.

Patients with carcinoma of the lung were given cough medicine, vitamins, the sulphonamides, penicillin, and, in a few instances, all the antibiotics now available. Two were even treated by roentgen ray therapy for thoracic tumors demonstrated by roentgenograms.

DELAY IN HOSPITAL

Condemnation of these physicians is undoubtedly justified, but it must not be too severe in view of what happened when the patients finally reached the hospital. Precisely the same errors of management were evident in a large number of cases. In carcinoma of the stomach the major error was both diagnostic and therapeutic: It was mistaken for gastric ulcer and treated accordingly. About a quarter of the 200 patients were affected, and both the proportion and the story were essentially the same as in the series studied in 1933 and 1941. Some patients had previous ulcer histories and had previously been treated for ulcers. Whether they really had benign lesions in the past it was usually impossible to determine, but it was all too clear that the disease from which they were presently suffering was not benign, though some of them were treated for weeks and months as if it were.

The errors in this latest series simply prove again what we ought to know without further proof, that it is utterly impossible to determine by any means short of surgical exploration whether one is dealing with a benign or a malignant gastric lesion. Again the Charity Hospital experience is not unique. Institutions like the Mayo Clinic, the Massachusetts General Hospital, and the Lahey Clinic have superior diagnostic facilities and are staffed by internists and surgeons with superior qualifications, yet their reported error in the preoperative diagnosis of ulcer versus cancer runs from 13 to 20 per cent.

In carcinoma of the lung there was perhaps more excuse for overlooking or not recognizing the malignant disease than there was in carcinoma of the stomach. Five patients in the series died of other causes, three of hemorrhage from peptic ulcers, one after eversion after closure of a ruptured peptic ulcer, and one of mesenteric vascular occlusion. Two did have advanced pulmonary tuberculosis as well as carcinoma of the lung, which was not recognized in either instance until many months had passed. In 41 cases of carcinoma of
the lung the clinical picture was completely atypical.

Many opportunities, however, were missed in both carcinoma of the stomach and of the lung. Patients in both groups developed their malignant disease quite literally under the eyes of the hospital staff. They were under treatment, sometimes for long periods of time, for hypertension, cardiac disease, diabetes, dermatologic and orthopedic conditions, cataracts, hernias, prostatic disease, and other transient and chronic conditions, to which all the attention was devoted.

In a separate category is the not inconsiderable number of patients who had been regular attendants at the hospital clinics over a period of years and who had been hospitalized a number of times, sometimes for trivial ailments, sometimes for serious ones. In one instance of carcinoma of the stomach the patient’s clinic record went back 20 years. It testifies to the insidious nature of carcinoma of the stomach and of the lung, as well as to the tendency of patients to ignore “inaugural” symptoms, that many of these men and women, with full knowledge of where medical care could be secured, and at no cost, simply failed to use the hospital facilities until, in most instances, it was too late for them to be helped.

What has just been said does not, however, account for all the delays in diagnosis and treatment in the hospital. Only 80 of the 200 patients with carcinoma of the stomach were operated on within 14 days of their admission, which seems a reasonable time to make a diagnosis if one had not already been made, and to prepare a patient for operation. In 132 of the 186 fatal cases of carcinoma of the lung the patients were under observation in the clinics or wards or both for periods ranging from two weeks to nine months before the diagnosis was established and surgery, when it was possible, was instituted. Only two patients were themselves responsible for these delays. One refused pneumonectomy for two months and the other for 11 months. When the latter returned, he had consumed five bottles of hadacol and he had, in effect, committed suicide.

Most of the delays in hospital can be accounted for by specific errors, which must be charged against the staff, not against the patients:

1. In some instances in which the diagnosis of malignant disease was positive or was strongly suspected, the patients were allowed to slip away from observation for long periods of time. When they returned, their disease was usually no longer amenable to curative surgery.

2. In some instances the initial investigations, undertaken with the idea of malignant disease in mind, were negative. They were complete enough, but when they did not confirm the clinical suspicion, that ended the matter, usually until it was too late for curative surgery to be undertaken.

3. In a few instances (and in all fairness it should be emphasized that there were only a few) the investigation was superficial and perfunctory.

4. In many instances, on the contrary, the work-up was far more detailed and repetitious than it need have been. Roentgenograms, bronchoscopic examinations, blood chemical determinations, cytologic studies and liver function tests were ordered, and many times were repeated, with an apparent reluctance to accept what seems, at least in retrospect, the clearcut evidence of the first reports. Again and again time was consumed in diagnostic refinements that might have been spent in hurrying the patients to the operating table. Two explanations present themselves for the over-elaborate work-up in many of these cases. The first is the ease with which, in a public institution, multiple laboratory tests can be ordered. The second is the perhaps unworthy suspicion that not much more was...
done with the reports of some of these tests than attach them to the charts.

5. In many instances in which the diagnosis was not immediately apparent the concept of prompt exploratory thoracotomy or laparotomy as a diagnostic aid seems to have been overlooked entirely.

LACK OF DIAGNOSTIC SUSPICION

Carcinoma of the stomach almost always appeared in the list of tentative diagnoses after the patient had reached the hospital, though it frequently did not head the list. On the other hand, it was disconcerting to observe, in the other series of cases, how many times carcinoma of the lung was omitted from the list of possibilities, even after the admission work-up and even in the most obvious cases. I would find it easier to believe, for my own part, that a 71-year-old man who complained of cough, dyspnea, wheezing and a weight loss of 32 pounds over a three-month period, had that disease than that he had a tumor of the posterior fossa, let alone such an absolutely rare condition as atypical thrombosis of the posterior inferior cerebellar artery. I suspect that in both series the reason for the omission of malignant disease as a prominent, if not the most prominent, diagnostic possibility is the interne and resident habit of recording details without marking and inwardly digesting them. Another explanation may lie in the unthinking acceptance of the notation entered on so many charts, that the patient did not look seriously ill. One agrees with the irritated British observer who said that to exclude carcinoma of the lung because a man does not look as if he had it is “ignorant, stupid, and almost contemptible.”

PSYCHIATRIC CONSIDERATIONS

A tendency evident in carcinoma of the lung, and evident for the first time in this third study of carcinoma of the stomach, was a rather prompt invocation of psychiatric causes to explain symptoms. Some patients in both groups were treated for their “nerves” before they were hospitalized. One patient with carcinoma of the lung actually got his prescription without ever being seen by the physician; his wife telephoned the doctor and the doctor telephoned the druggist.

That is bad enough. It is more disturbing to see the same trend evident in the outpatient clinics and in the hospital. Seven patients with carcinoma of the stomach had neuropsychiatric consultation and active treatment. In ten cases of carcinoma of the lung, nervousness, hysteria and other neuropsychiatric causes were advanced to explain symptoms, many of them referable to the chest, before pulmonary malignancy was even considered. These explanations were seriously advanced in three cases in which the patients were seen for the first time ten, nine and eight days before they died and before there had been any serious work-up. Another patient was treated for conversion hysteria by reassurance therapy for six months, and still another was repeatedly referred to the neuropsychiatric clinic for evaluation. A number of patients with carcinoma of the stomach were submitted to palliative surgery, but not a single patient thus treated in either group was suitable for curative surgery when the correct diagnosis was finally established.

I am not blaming the neuropsychiatrists for these errors. They have a right to assume, when patients are referred to them, that organic disease has been excluded. I am perfectly willing to admit that even malignant disease may have a large functional overlay. I am certainly not prepared to say that the outcome would have been different in any of these cases without the delay for psychiatric investigation and treatment; in some instances of carcinoma of the lung I am certain that it would not have been. But I am deeply impressed by the fact that in many of these cases the diag-
nostic vein was scarcely tapped, so to speak, before the concept of psychosomatic disease was introduced. And what disturbs me most of all is the readiness with which, as these histories indicate, residents, internes, and even medical students reach for this concept as the simplest explanation of any and all symptoms and recommend neuro-psychiatric evaluation as a simple method of disposing of a patient who presents a diagnostic problem. We may have been too slow to accept psychosomatic disease in the past, but we are treading on dangerous ground now when we employ the concept so readily and so credulously.

POSSIBILITIES OF IMPROVEMENT

It is a tragic fact that the delays and errors which I have just discussed seem to have made no great difference in the end results in most cases in either of these series. Only 33 of the 186 patients with carcinoma of the lung were submitted to pneumonectomy, which was designed to be curative in only seven cases, and only 22 others could be explored. The hopeless status of most of the patients who were not operated on is evident in the brevity of their lives after they were first seen in the hospital; 89 died within two months of the time they applied for treatment.

In carcinoma of the stomach the situation is a little brighter. One hundred one of the 200 patients were submitted to gastrectomy, which was intended to be curative in 43 cases. On the other hand, 36 of the 90 gastrectomized patients who survived operation and could be followed up are known to have died within two to 36 months after they left the hospital.

For the ultimate problems of malignant disease of the stomach and the lung I have, of course, nothing to propose. I hold the thought, optimistic or pessimistic as you choose to regard it, that until some biologic test is devised which will do for these diseases what the blood serologic test has done for syphilis, we shall continue to wander in the dark. I do not mean to depreciate research along other lines when I say that until we can diagnose malignant disease while it is still early, and preferably while it is still latent or subclinical, no technical or other skill will avail these patients. Nor do I mean to be cynical when I say that whatever test is finally devised must be simple, painless, and quickly performed; people will not readily submit to being inconvenienced. That disposes of such screening methods for carcinoma of the stomach as photofluorography, while mass radiography of the chest, although it is the best method presently at our disposal, has been gravely disappointing in the identification of operable cases of carcinoma of the lung.

The points which I have raised in this discussion do, however, suggest a number of ways in which our present management of these two diseases can be improved. They have to do with both medical practice and medical teaching:

1. Chest physicians now know that carcinoma of the lung is perhaps the most frequent malignant disease in men, at least in middle and later life, much more frequent, in fact, than virus pneumonia or, if such a condition really exists, than unresolved pneumonia. Physicians who do not specialize in diseases of the chest apparently have not yet realized this, perhaps because the proof is so recent.

Similarly, a great many physicians, including gastro-enterologists, have not yet come to appreciate the difficulties of differentiating gastric ulcer from gastric cancer. Thousands of physicians have not yet realized the excellent potentialities of pneumonectomy and gastrectomy when they are performed under optimum circumstances, as they seldom are today. Nor do they realize with what negligible risks exploration of the chest and the abdomen are now attended, and what valuable diagnostic aids these simple procedures can be.
2. The results in both diseases would be immediately and materially improved if surgeons were invited to see the patients as soon as the suspicion of malignant disease was entertained. If this practice was introduced, I venture to say that less laboratory work would be required and that the period of work-up would be perceptibly shortened. It is still hospital policy to admit patients with respiratory and gastric symptoms to medical wards, even when malignant disease is strongly suspected; however, it is not a good policy. In 1903 W. J. Mayo expressed himself bluntly about it as it concerned gastric cancer, and I am sure, were he alive today, or had carcinoma of the lung been the problem then that it is today, that he would be, or would have been, equally blunt about it.

3. We must try to make it clear that symptoms must not be treated until causes are determined, most of all in middle-aged men with gastric and respiratory symptoms. The error of medical treatment of malignant disease is much more serious today than it was when Moynihan said that the successful treatment of presumed gastric ulcer is a fundamental cause of the mortality of actual gastric cancer. The antiacids are more numerous and more efficient. There are more and more efficient cough syrups, and we now have numerous antibiotics. As these agents multiply and increase in efficiency, I have no doubt that the situation will worsen. Even now the infections so commonly associated with carcinoma of the lung respond satisfactorily, and sometimes dramatically, to antibiotic therapy, while the primary disease may thus be masked for an indefinite period of time.

Our patients, of course, will not like such a policy. It is no longer surprising to be told what therapy is expected, or to hear one or another of one's associates condemned because he did not prescribe penicillin or aureomycin or whatever it is that has just cured the patient's wife or his mother or his baby. We shall have to make very plain to such patients that they may lose their lives if they are treated first and investigated second. We must, it seems, add information about the risks of the antibiotics to our campaigns of education about malignant disease.

4. We must put more emphasis upon our teaching about malignant disease. The interne and resident staff of Charity Hospital has been the chief scapegoat in these remarks, and I should make it clear that these young men represent not only the two local medical schools but many other schools from all parts of the country. What is very clear from my analysis of these two series of cases, and from my observations and contacts in this and other hospitals, is that the great majority of them do not seem to have been taught the extreme urgency of malignant disease. It was Carnett, I believe, who, when he encountered a woman with a lump in her breast, dismissed the other patients in his office and took her to the hospital at once in his own car. The gesture may be dramatic but no fault can be found with the idea.

Our concepts of malignant disease of the stomach and the lung, and our teaching concerning them, should be about as follows:

A. Since both diseases may exist with minimal symptoms, or with no symptoms at all, the only way to detect them while they are still curable is to maintain a high and constant index of suspicion about them.

B. The clinical history is still the most reliable method of diagnosis in both diseases.

C. Laboratory studies furnish merely adjunct evidence, which must be discounted if it runs counter to reasonable clinical suspicion.

D. Exploratory laparotomy and thoracotomy are diagnostic aids, to be used whenever the diagnosis of carcinoma of the lung or the stomach cannot be definitely estab-
lished or cannot be excluded with equal finality.

E. Both of these tools, furthermore, must be employed promptly if the diagnosis cannot be established or excluded promptly. The leisurely pace of our investigative routine, plus the inertia that so often fails to overcome the niceties of hospital red tape and protocol, accounts for many deaths in both these diseases. We must put an end to roentgen ray appointments two months off and the "return in two weeks for observation" method of procedure.

All the charts in both these series had student as well as interne-resident histories. One student wrote, in a case in which the diagnostic progress had been unusually slow, "I say this man has carcinoma of the stomach and I'll have to be shown that he doesn't." That attitude will not take care of the silent cases of malignant disease of the stomach or the lung, but it will go far toward expediting the treatment of patients with manifest symptoms. My principal suggestion is that we try to breed more medical students with that kind of approach to the problem.

SUMMARY

Investigation of recent series of cases of carcinoma of the stomach and the lung from Charity Hospital of Louisiana at New Orleans, revealed a number of disturbing factors, including (1) no recent improvement in the duration of symptoms before medical consultations; (2) mistaken therapy, directed toward symptoms before causes were investigated, both in and out of the hospital; (3) long delays in hospital before diagnosis was established and treatment instituted; (4) lack of diagnostic suspicion; and (5) the tendency, in a small number of cases, to resort to neuropsychiatric causes to explain symptoms of organic origin, often before any serious attempt at diagnosis had been made.

The enumeration of these erroneous tendencies indicates methods of correcting them. Most important of all are (1) maintenance of a high and constant index of suspicion; (2) the use of laboratory studies only as adjuncts to clinical observation; (3) the prompt use of exploratory thoracotomy and laparotomy as diagnostic measures; (4) the establishment of an incontrovertible diagnosis before either gastric or respiratory symptoms are treated by any method at all; and (5) constant stress upon the urgency of malignant disease, particularly to medical students.

BIBLIOGRAPHY

ERRORS IN DIAGNOSIS OF CARCINOMA OF STOMACH


DISCUSSION.—Dr. WALTMAN WALTERS, Rochester, Minn.: I did not intend to discuss this paper, but it seems to me that it is of such great value that it would be a great mistake if it were not discussed. I have had the pleasure of hearing and reading Dr. Boyce's summaries of thirty years of work on cancer of the stomach and its treatment, in recognition and so on, at the Charity Hospital in New Orleans. He has presented material on cancer of the stomach on three previous occasions with an interval of ten years between each presentation. I think that those of you who study the data he has presented on these three occasions, the last being at the meeting of the American Medical Association in June, cannot help but be impressed by two things. First, that as the result of his interest, and perhaps that of others, and the stimulation of the others in charge of the gastroenterologic service and the training program of surgical residents, there has been a 48 per cent improvement in the resectability rate during this period of three decades. But more than that, there has been a 50 per cent reduction in mortality rates. This is a very commendable accomplishment. I had the pleasure ten years ago and again this June, of discussing Dr. Boyce's papers. I had the temerity ten years ago to say that I believed the difference between the mortality rates in some of the teaching hospitals and those in some of the clinics and private hospitals, and for private cases, was due to the fact that insufficient experience was being given to the men who were doing the resections. That I think is proved now in Dr. Boyce's discussion, which is further emphasized by his report that, whereas prior to ten years ago total gastrectomy had not been performed in his series, there have been 11 cases since.

It is rather difficult for a man who is in my position—being a surgeon in a private clinic and a teacher of surgery in a graduate school of medicine of a midwestern university for more than 28 years—to discuss a residency program of a university charity hospital. Yet I do think I am not amiss in interjecting a comment here, because it is an important point in Dr. Boyce's paper. When patients with suspected gastro-intestinal lesions in any hospital in this country are allowed to rest on any service for from two weeks to several months, particularly when there is a question of cancer of the stomach, there is something wrong with the training program. I am not directing my criticism to one particular hospital. I am trying to express again the viewpoint which I expressed ten years ago, that if we are going to make our residency program function in the most practical and acceptable way as a means of teaching the practice of clinical surgery, the work of the residents must be closely supervised. Furthermore, clinical and laboratory studies which are carried out should be related to the illness of the patient and should be of assistance in the therapy that is to be carried out. This program will enable the patient to receive better care, will be of greater value to the resident, and will be less expensive to the hospital and to the patient.

Dr. J. M. T. FINNEY, Jnr., Baltimore, Md.: I would like to add my word of commendation to what Dr. Boyce has said. At meetings such as this it is of intense interest, of course, to hear all the latest scientific advances, all the new ideas which may or may not eventually have some application in practical surgery. However, I do think that there is a place every now and then (I tried to fill a small part of it night before last) when a period of self-examination is very much in order; when we look at ourselves critically and try to evaluate the job we are doing in passing on to the succeeding medical generation those things which we have learned, often from bitter experience, and which we do not want them to have to learn all over again in the same rough school. It is just such papers as that of Dr. Boyce which call attention to some of the obvious defects in present day practice and teaching as they may affect the ultimate condition of the patient who, after all, is the one in whom we are most interested. It is just such papers as this which on occasion cause us to pause and consider whether we actually are doing the best we can and, if not, in which direction to turn to try to do better.

I compliment Dr. Boyce on this presentation.

Dr. WILLIAM H. PHOOLE, Charleston, S. C.: I rise not to defend the resident training program.
and those in charge of it, as there are others better qualified to do so, but to emphasize the economic factor which accounts for so much delay in diagnosis and treatment. We have some cases in which diagnostic measures are unduly extensive and time-consuming; however, these do not represent a great number. The lack of operating room facilities is the most important factor in the delay between completion of the diagnosis and institution of treatment. In our tumor clinic, the cancer cases requiring major surgery commonly have to be scheduled several weeks ahead, and not infrequently longer than this. At times, when we obtain the operating room, we find that we cannot get adequate anesthesia service. A solution to this problem is our most pressing need.

BOOK REVIEW

SURGERY OF HERNIA (Chirurgie der Hernien). Karl Vogeler. Published by Walter de Gruyter & Co., Berlin. 139 pages; 102 illustrations.

This small monograph on the Surgery of Hernia consists of a compact book of 139 pages with an index and bibliography. There are 102 illustrations, some of which are reproductions from previous publications, but all of which are either clear photographs or clear drawings. For those interested in the subject of hernia, this monograph presents a good review of the subject as seen from the Continental viewpoint. Most of the references are to European authors. Such subjects as the Cooper's ligament repair and the use of steel wire and tantalum mesh do not receive the mention that interest in them in this country would indicate. In the repair of femoral hernia the femoral approach is emphasized. Despite these possible objections, the book is well printed and presents a good exposition of some of the classical views concerning the surgery of hernia.

HENRY N. HARKINS

VAC

No further text available.
VAGOTOMY AND GASTRO-ENTEROSTOMY—VAGOTOMY AND CONSERVATIVE GASTRECTOMY

A COMPARATIVE STUDY*

L. W. Edwards, M.D. AND J. Lynwood Herrington, Jr., M.D.

NASHVILLE, TENNESSEE

FROM THE DEPARTMENT OF SURGERY OF THE VANDERBILT UNIVERSITY SCHOOL OF MEDICINE

Nine years have passed since vagotomy was re-introduced by Dragstedt and Owens in the treatment of duodenal ulcer. Cumulative evidence during the past few years has clearly shown that, although vagotomy promotes ulcer healing in the majority of instances, certain undesirable side effects detract from its usefulness. At the present time vagotomy combined with gastro-enterostomy and vagotomy combined with gastric resection are gaining increasing popularity in some clinics; however, considerable controversy exists as regards the merits of these procedures compared with radical subtotal gastrectomy.

Prior to a few years ago we had always performed subtotal gastric resection for duodenal ulcer, removing approximately 75 per cent of the stomach along with the ulcer bearing area of the duodenum whenever feasible. At first glance our results appeared gratifying, but on careful study it became apparent that some patients continued to experience digestive disturbances necessitating a strict dietary regimen. Not all were able to gain weight or maintain their preoperative weight levels, and the development of anemia was a problem in some. Thus it appeared obvious that the operation did not restore the individual to a normal state in many instances. The short term follow-ups were encouraging as regards recurrent ulceration, but with the passage of time we began detecting cases of marginal ulceration which made us further question the efficacy of adequate subtotal resection.

Coexistent with our dissatisfaction regarding our resection cases, the early reports favoring vagotomy began to appear in the literature. Perhaps influenced more by our own results than for other reasons, we began to utilize vagotomy in the surgical treatment of duodenal ulcer.

STUDY OF PATIENTS

This communication serves to relate our experience covering a six year period from 1946 through 1951, during which time we performed vagotomy as an integral part of all operations for duodenal ulcer.

A total of 121 patients were subjected to surgery with two hospital deaths (mortality 1.6 per cent) and five patients have subsequently died during the interim follow-up. Thus, this report comprises our results in 114 cases. With few exceptions each patient has been carefully questioned and examined on repeated occasions by one of us. The majority have been subjected to gastric secretory studies including pH determinations and the insulin test. We have been critical in our evaluations and a result is recorded as excellent only if the patient is entirely free of all digestive symptoms. If occasional epigastric fullness is noted, occa-
sional diarrhea or mild symptoms suggesting the dumping syndrome, then the result is listed as satisfactory. If the postoperative complaints are pronounced, or if the individual has not profited considerably by the operation, the result is termed poor.

The cases may be conveniently divided into four groups (Fig. 1) in accordance with the type operation performed: (1) Vagotomy employed as the sole procedure; (2) vagotomy combined with gastro-enterostomy; (3) vagotomy coupled with resection of the pyloric end of the stomach (pylorectomy) leaving the major portion of the pyloric antrum intact; (4) vagotomy combined with removal of the entire pyloric antrum (antrectomy). In the latter two groups the ulcer bearing duodenum was removed in the majority of cases.

VAGOTOMY ALONE

During our early experience 17 patients underwent vagotomy as the sole operative procedure, the transthoracic approach being utilized in two and the transabdominal route in 15. There were no hospital deaths but one patient has since died of causes unrelated to ulcer disease. Studies in the remaining 16 (Fig. 2) reveal that seven, or 44 per cent, are entirely free of digestive complaints, all have gained weight, and the period of observation now extends between four to six years. The ulcers have all remained healed as evidenced by roentgen examinations; however, one patient has a positive response to insulin hypoglycemia.

Four patients, or 25 per cent, continued to experience occasional diarrhea and epigastric fullness following a heavy meal. However, all are pleased with the results, and the ulcers have remained healed after four to five years.

Five patients, or 31 per cent, have obtained a poor result. Four in this group developed marked gastric atony necessitating a drainage operation in one. The other three patients have improved with the passage of time. One patient received an incomplete vagotomy as evidenced by the persistence of ulcer-type pain along with hypersecretion and a positive insulin test. He is being maintained fairly well on Banthine at the present time.

VAGOTOMY AND GASTRO-ENTEROSTOMY

Studies have clearly demonstrated that when gastro-enterostomy is added to vagotomy, the results are superior to those obtained with vagotomy alone. The troublesome side effects are abolished in many instances, or else substantially ameliorated.

Vagotomy and posterior gastro-enterostomy has been performed on 39 patients; one has since died of unrelated causes, and the results have been ascertained on the remaining 38 (Fig. 3). Twenty-three patients, or 60.5 per cent, are listed as obtaining an excellent result. Of this number 17 have gained from five to 30 pounds in weight, five have maintained their preoperative weight, and one patient has lost approximately five pounds since undergoing surgery. Eighteen of the group have been followed three to six years. It is of interest to note that two patients have positive insulin tests but both have remained free of symptoms three and five years respectively since operation. Their ulcer craters have remained healed and no evidence of stomal ulceration has been obtained.
VAGOTOMY AND GASTRO-ENTEROSTOMY

Ulceration can be demonstrated in either case.

Eleven patients (29 per cent) continue to experience some digestive disturbances but none complain of ulcer-type pain and no roentgen evidence of recurrent ulceration has been demonstrated. All are able to perform a useful occupation and all are satisfied with the results obtained by the operation. For the most part the complaints are mild indeed, and include transient fullness and eructations following meals, epigastric soreness, and symptoms suggestive of the dumping syndrome. Occasional diarrhea was noted in three patients but persistent diarrhea has not been a problem. Failure to gain weight has, however, been observed frequently in this group as perhaps the patients tend to restrict their oral intake for fear of increasing the postprandial symptoms. Anemia has not been encountered as a postoperative problem.

Four patients (10.5 per cent) are listed as obtaining a poor result. Two in the group operated upon two and five years ago respectively continue to complain of ulcer-type distress since operation and repeated insulin tests show positive findings. Fluoroscopic and roentgen studies have failed repeatedly to demonstrate a crater, but persistent duodenal ulceration or ulceration at the stomal site are still likely possibilities. Two patients continue to complain of gastro-intestinal discomfort to the point of being unable to perform their duties. Studies show no evidence to support their complaints.

VAGOTOMY AND PYLORRECTOMY

Thirty-one patients have undergone vagotomy combined with a very limited resection in which only the pyloric end of the stomach was removed. One death occurred during the follow-up period, the remaining 30 patients have been subjected to study (Fig. 4).

Twenty-four patients (80 per cent) have been relieved of all gastro-intestinal symptoms and each terms the operation unquestionably a complete success. Of this number, 17 have gained weight and seven have maintained their weight prior to operation. The majority have been followed almost two years, a few patients having been observed almost three years.

In three patients (10 per cent) the result has been satisfactory. Occasional epigastric fullness is experienced in one case and in the other two, the dumping syndrome is a source of postoperative discomfort. There is no evidence of recurrent ulceration and the patients are perfectly satisfied with the operation.

In three patients (10 per cent) the result has been poor. One patient, now almost three years after his operation, continues to
experience epigastric pain and the insulin test shows a positive response. The other two patients note excessive fullness and complain of abdominal soreness but no characteristic ulcer-type pain. Recurrent ulceration has not been demonstrated

VAGOTOMY + PYLORRECTOMY

30 CASES

80% EXCELLENT
24 PTS.

RESULTS

10% SATISFACTORY
5 PTS.
10% POOR
3 PTS.

PATIENTS YEARS YRS. YRS.
7 2-3 3am i-2 3am pe 2-3
17

FOLLOW-UP

Fig. 4

VAGOTOMY + ANTRECTOMY

30 CASES

83% EXCELLENT
25 PTS.

RESULTS

7% SATISFACTORY
2 PTS.
10% POOR
3 PTS.

PATIENTS YEARS YRS. YRS.
1 2-3 3am 1-2
6 4-5 2 1-2
13

FOLLOW-UP

Fig. 5

radiographically in any of the three patients, though it is strongly suspected in one.

VAGOTOMY PLUS ANTRECTOMY

Vagotomy coupled with resection of the pyloric antrum has been performed on 34 patients. Two hospital deaths occurred in this group and two patients have since died of unrelated causes. Follow-up is complete on the 30 remaining patients (Fig. 5).

Twenty-five patients (83 per cent) term the operation entirely successful and none has residual gastro-intestinal discomfort. Eighteen of this number have gained weight since operation. Nineteen of the group have been followed between three and five years and one patient has been observed almost six years.

Two patients (7 per cent) experience transient fullness after meals, but gastrointestinal study reveals normal findings and neither patient shows a free acid response to cephalic or to humoral stimuli.

Three patients (10 per cent) have received no benefit from surgery. They continue to note vague sensations in the upper abdomen along with nausea and vomiting on occasions. All three have marked psychoneurotic backgrounds and in retrospect were poor candidates for surgery. Repeated studies have shown no evidence of gastric stasis or recurrent ulceration, and insulin tests reveal negative responses.

DISCUSSION

It is generally agreed that gastric retention constitutes a major problem in some patients following vagotomy alone, but on the other hand this study as well as others shows that a few patients, even after several years, are continuing to fare exceedingly well.

Following vagotomy and gastro-enterostomy, Dragstedt reports 90 per cent of cases relieved of objective evidence of ulcer and of ulcer distress. Residual complaints were noted in 10 per cent, but in some of these cases the ulcers have remained healed. Crile has obtained 69 per cent excellent results with vagotomy and gastro-enterostomy, and an additional 21 per cent listed as good results continue to experience mild digestive complaints. His studies cover a two to four year follow-up and are based on clinical evaluations only. Grimson's analysis of cases over a seven year period represents a more detailed study and the results thus far are encouraging.
It is obvious from a study of the group of 38 patients that gastro-enterostomy added to vagotomy alleviates in large measure the marked gastric atony associated with vagotomy alone. Excellent results in 60.5 per cent of cases surpass most of the figures in the literature ascribed to vagotomy alone. It is with the patients in the group termed satisfactory results (29 per cent) that we have displayed our greatest concern. Although the complaints appear trivial in comparison to the ulcer distress prior to surgery, the results, nevertheless, leave something to be desired.

There are certain objectionable features, both theoretical and real, which may be ascribed to vagotomy and gastro-enterostomy. (1) The procedure creates an additional exit from the stomach in addition to the existing pylorus which may also continue to function in cases where preoperative obstruction was not a factor. A dual route of emptying does not appear to be physiologically sound, and this could conceivably be the source of undesirable side effects. (2) An increase in pyloric tone has been recorded in experimental animals following vagotomy and the possibility of this factor playing a major role in the human does exist. (3) The presence of a well functioning gastro-enteric stoma precludes adequate filling of the duodenal bulb on radiologic examination, thus rendering it difficult to evaluate ulcer healing. (4) The operation fails to remove the pathologic lesion which we feel should be done whenever feasible.

It appears reasonable, therefore, to postulate that an operation directed toward eliminating the factors enumerated above and designed to preserve storage function of the stomach, might conceivably reduce the postoperative complaints and improve the overall results. Beattie, being cognizant of the relative failure of vagotomy and gastro-enterostomy to achieve excellent results in some cases, has added partial pyloroplasty and pyloroplasty with good success. Granted that pylorospasm may be a factor responsible for certain of the postoperative complaints, then a procedure designed to remove the pylorus and ulcer bearing duodenum in addition to vagotomy would appear physiologically sound.

It is apparent on comparing the vagotomy and pyloroplasty group with the patients undergoing vagotomy and gastro-enterostomy, that the most striking difference noted is the marked diminution of gastro-intestinal complaints of a minor nature experienced by the former. It is intriguing to speculate that this improvement might have occurred through elimination of the pylorus.
Following complete vagotomy and pylorectomy, there remains no free HCL response during fasting states and the secretory response to histamine is reduced comparable to that obtained with vagotomy and gastro-enterostomy. It must be remembered that in removing the pylorus, the major portion of the antrum is left intact (Fig. 6), thus accounting for the secretory response obtained with the usual test meals. Dragstedt\(^{26}\) has shown in the experimental animal that resection of one-half to two-thirds of the antrum produces no decrease in the hormonal phase of gastric secretion.

Vagotomy combined with gastric resection in the treatment of duodenal ulcer is not a new concept. Klein\(^{18}\) in 1929 reported carrying out unilateral vagotomy and partial resection in eight cases. Orr and Johnson\(^{20}\) utilizing vagotomy and hemigastrectomy, report encouraging results in patients followed up to two years. Colp and his group,\(^{13}\) during a five year experience with 322 ulcer cases, report no proven instance of marginal ulceration in those patients receiving vagotomy plus resection, but distant nine cases of recurrent ulceration and two questionable cases in patients subjected to gastric resection alone. In Smithwick's\(^{19}\) excellent study, results with a 50 per cent resection and vagotomy were superior to those obtained following radical resection with or without vagotomy.

Schoen and Griswold\(^{23}\) have demonstrated that the vagotomized stomach is capable of producing active gastric juice. Therefore, combining vagotomy with antral resection, thus eliminating both phases of gastric secretion, should theoretically offer maximum protection against recurrent ulceration. The operation has the added advantage of preserving the storage function of the stomach. Hypersecretion of antral origin with resultant ulcer formation has been demonstrated in the experimental animal,\(^{11}\) and although the significance of antral hyperfunction in man is questioned, the possibility does exist. It is generally agreed that the goal of any operative procedure designed for duodenal ulcer is to produce a state of achlorhydria, as recurrent ulceration is rare in the absence of free HCL. In Dragstedt's\(^{25}\) animal experiments no consistent effect of antral resection on the gastric secretory response to histamine was found; however, in our patients undergoing vagotomy, plus a marginal ulcer, achlorhydria was not present. The secretory responses from such states are a manifestation of relative resection and are explained by the sensitization of the barium meal.

The portion of the antrum which is left intact with the pyloroplasty and pyloroplasty combined is followed by a pH study of the duodenal juice. The operative results of the Fic. 7.—Average pH studies of normal (control) individuals and those of long range postoperative patients subjected to various operations for duodenal ulcer. (The vagotomy and antrectomy group have a pH approaching neutrality with all stimuli.)

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**Fig. 7.—Average pH studies of normal (control) individuals and those of long range postoperative patients subjected to various operations for duodenal ulcer. (The vagotomy and antrectomy group have a pH approaching neutrality with all stimuli.)**

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**Fig. 8.—A thorough dissection of the periesophageal area is necessary to obtain a complete vagotomy. Insert shows the fibrous and areolar tissue on either side of the esophagus being divided and ligated.**

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The path of the vagus nerves follows a very constant course. For the purpose of this operation they are identified by abdominal palpation above the dia
dous arc held by the operator. Care should be taken not to injure the recurrent laryngeal nerve, which arises from the vagus and descends on the back of the trachea in the neck. The operation is performed through a right subcostal incision extending from the umbilicus downward to a point one inch above the iliac crest. The free edge of the right lobe of the liver is lifted upward to expose the area between the posterior surface of the esophagus and the thoracic wall.
plus antrectomy, there has remained an achlorhydria to histamine as well as a negative free acid response during the fasting states and to test meal stimulation. A negative response to histamine may possibly be explained on the basis of a diminished sensitivity of the fundic glands.

The follow-up on the vagotomy and antrectomy group compares quite favorably with the patients subjected to vagotomy and pylorectomy. The former group has been followed longer and the vast majority of the complaints, experienced by the vagotomy and gastro-enterostomy patients, have been absent from both groups. In patients examined five years following vagotomy and antrectomy there have been no detrimental effects resulting from ablation of both phases of gastric secretion. The gastric secretory volumes have remained low and gastric stasis has not been encountered.

Determinations of the $\phi$ pH* of the gastric contents have been performed on normal (control) individuals, those with active duodenal ulceration, patients undergoing a 75 per cent resection without vagotomy, and patients subjected to the gastric operations under consideration (Fig. 7). It is of interest to note in the vagotomy and gastro-enterostomy group that on test meal and histamine stimulation, peptic activity, as measured by hydrogen ion concentration, approaches the range of that found in patients with active ulcer disease. Vagotomy and pylorectomy result in a decrease in peptic activity roughly paralleling that of vagotomy and gastro-enterostomy. From the chart, one gains the impression that vagotomy plus antral resection reduces peptic activity to a minimum and under these circumstances, recurrent ulceration would appear unlikely.

One definite drawback to vagotomy is the likelihood of the operator performing an incomplete nerve division. As previously mentioned in the "vagotomy alone" group, one patient with an excellent result and another with a poor result have positive insulin tests. In the vagotomy and gastro-entero-

\[\text{VAGOTOMY + ANTRECTOMY}\]

* $\phi$ pH determinations performed with the Beckman pH meter.

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VAGOTOMY AND GASTRO-ENTEROSTOMY

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Fig. 9.—To insure complete antral removal, the stomach is divided at the level of the incisura angularis.
ical result and that healing of the ulcer may take place at times even though the vagotomy has been incomplete. This concept (Dragstedt)\textsuperscript{12} is based on the persistence of a meager vagus innervation which may not respond to the usual cephalic stimuli, but a response may be obtained when a potent stimulus like insulin is introduced. One patient with a poor result in the vagotomy and pyloroplasty group has a positive insulin response. We have not, as yet, encountered a negative insulin response in any patient which has later reverted to positive. It is our feeling at present that a positive response is indicative of an incomplete vagotomy.

It is not unusual in approximately 18 to 25 per cent of patients to find at operation a fairly large accessory vagus nerve in addition to the two main trunks. If the operator divides all fibrous and areolar tissue on either side of the esophagus, the loose tissue lying between the esophagus and aorta, he will be rewarded in many instances by finding small nerve fibers present when microscopic examination of the tissue is carried out. It is our practice, also, to strip the circumference of the esophagus bare, down to the longitudinal musculature (Fig. 8).

At the present time, although the follow-up period is short, we feel that vagotomy combined with a conservative gastric resection has promise in the treatment of duodenal ulcer. Our preference favors the procedure in which the antrum of the stomach is removed (Fig. 9), and to insure its complete extirpation, the resection is carried proximally to the region of the incisura angularis. In reality the operation entails removal of slightly more than the antral segment and provides a 35 to 40 per cent resection. A Billroth II type of reconstruction is carried out.

**SUMMARY**

A six year surgical experience with duodenal ulcer has been presented in which vagotomy played an integral part in each operation.

Results thus far indicate that vagotomy combined with antral resection may have promise in the surgical treatment of duodenal ulcer.

**ACKNOWLEDGMENT**

The authors wish to express their appreciation to Dr. John Conigliio and Dr. Oscar Touster of the Department of Biochemistry of the Vanderbilt University School of Medicine for their cooperation in making possible the pH determinations.

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VAGOTOMY AND GASTRO-ENTEROSTOMY


DISCUSSION.—Dr. J. LYNWOOD HERRINGTON, Nashville, Tenn.: Again I would like to express my appreciation for being extended the privilege of the floor.

Vagotomy and posterior gastro-enterostomy patients, even though completely vagotomized according to the standard insulin test, have continued to secrete rather large amounts of gastric juice during the fasting state, and of course this is true upon test meal and histamine stimulation. The concentration of free acid is, however, markedly reduced during the fasting state, and there is significant peptic activity upon stimulation with a test meal and histamine. The same is true in the vagotomy and pyloroplasty group. As Dr. Edwards has stressed, the vagotomy and pyloroplasty patients fare better clinically than the vagotomy and gastro-enterostomy patients and we feel that probably this is due to the removal of the hypertonic

Also I would like to bring out two points which are covered in the paper but which Dr. Edwards did not have time to mention. (Slide) Average pH determinations have been carried out on the gastric contents of a group of normal control individuals, patients with active duodenal ulceration, patients subjected to a 75 per cent gastric resection without vagotomy, and patients subjected to the various gastric operations under consideration. I might add that these are all long range pH studies, the majority of them having been done several years postoperatively. One readily sees that in the vagotomy and gastro-enterostomy group, peptic activity as measured by the hydrogen ion concentration is markedly reduced only during the fasting state, and there is significant peptic activity upon stimulation with a test meal and histamine. The same is true in the vagotomy and pyloroplasty group. As Dr. Edwards has stressed, the vagotomy and pyloroplasty patients fare better clinically than the vagotomy and gastro-enterostomy patients and we feel that probably this is due to the removal of the hypertonic

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pylorus. But as you see, physiologically the two groups are about the same. Following 75 per cent gastric resection without vagotomy the patients still have significant peptic activity on histamine stimulation, but they are well protected during the basal state and upon test meal stimulation. In the vagotomy and antrectomy group, in which an estimated 40 per cent of the stomach is removed, peptic activity is reduced to a minimum, as you see here, and the hydrogen ion concentration of the gastric contents approaches neutrality with the various stimuli. These findings in the last-named group are in keeping with Dr. Smithwick's figures, in which he has carried out a vagotomy coupled with an estimated 50 per cent gastric resection. Dr. Dragstedt has shown that antral hyperfunction is certainly of importance in producing ulceration in the experimental animal, and here he feels now, I believe, that the possibility of it existing in the human is a factor to be considered.

One further point I would like to make is that a very meticulous dissection of the peri-esophageal area is necessary in carrying out vagotomy to be assured of its completeness. I feel sure that some of the poor results in the literature ascribed to vagotomy are due to the operator performing an incomplete nerve section. It has not been unusual in our cases to find a fairly large third nerve trunk to the left of the esophagus, buried in the tissue, which can easily be missed.

(Slide) Also we make it a point to divide all fibrous and areolar tissue for a distance of 2 to 3 cm. on each side of the esophagus. We also remove all loose tissue between the esophagus and the anterior wall of the aorta. If this tissue is sent to the laboratory, many times one will be rewarded by finding microscopic nerve filaments present.

Dr. Frank H. Lahey, Boston, Mass.: This very interesting paper reopens a subject that has been discussed a great deal over the past few years, often with too much pride and equally sometimes with too much prejudice. I think it is important for all of us dealing with many peptic ulcer cases to establish our opinions and experiences regarding vagotomy—when we use it, when we do not, and what, in our experience, its relationship in value is to subtotal gastrectomy.

Let us start with basic principles that were established by one of the discussors and one of my friends, Dr. Dallas Phemister, when the American Surgical Society met in Colorado Springs. We must view this whole subject from the point of view of the accepted fact that ulcer is intimately and probably irrevocably related to high gastric acidity, and that there are three phases of gastric acidity, two of which are surgically controllable; the cephalic phase through the vagi, and the gastric phase by means of varying degrees of gastric resection. With these in mind, we have to relate some other data to this comparison, that is, the report of the Vagotomy Committee of the American Gastro-enterological Society, of which Dr. Sara M. Jordan was the chairman, and which consisted of four gastro-enterologists, Waltman Walters and Francis Moore, two scientists in the basic sciences, and a statistician. So that an unprejudiced opinion could be arrived at as to the relative value of each procedure, we must throw out those opinions which are prejudiced either way, and I mean to be frank about it; it is often very difficult for some persons to see anything wrong with it, and some become so prejudiced against it that they cannot do it justice. That has been especially true of this operation. You will read in the literature, many more reports each year in opposition to the Finsterer resection by exclusion, even with the removal of the mucosa as proposed by Doctor Bancroft. It is a messy and uncertain method of closing the prepyloric stump.
VAGOTOMY AND GASTRO-ENTEROSTOMY

in the presence of an eroding and indurated duodenal ulcer. It has, in addition, the danger of flowing out when the ulcer obstructs the duodenum.

I think we have to stress the fact that one of the reasons that the mortality in subtotal gastrectomy for gastric ulcer is less than that for duodenal ulcer is because the surgeon does not have to worry about safe closure of the duodenum, the avoidance of the common duct and the point where it and the pancreatic duct enter, together with the danger of promoting pancreatitis when the ulcer must be dug out of the head of the pancreas to get a good closure. I would urge, therefore, that when you operate for a duodenal ulcer you look at the ulcer and decide how easy it is going to be to remove it and how well the duodenal stump is going to be turned in afterward, because when leakage and duodenal fistulas occur, the mortality is going to be high. It is in cases such as these, and those in which the patient is a bad risk (fat, flabby, old and with very adherent ulcers) that vagotomy and gastro-enterostomy is done. This is the position that we have taken toward vagotomy. We have tried to make a decision by which the mortality can be controlled, when the ulcer is first exposed, based on how easily and how safely it can be removed.

DR. LEONARD W. EDWARDS, Nashville, Tenn. (closing): I want to thank Dr. Lahey for his very instructive and interesting discussion. In most cases we can remove the ulcer and get safe closure of the duodenum; there will be an exceptional case, of course, in which vagotomy and posterior gastro-enterostomy should be done. Patients with resection of 40 per cent of the stomach with complete vagotomy, we find, are happier and are in better physical condition than the cases in which we removed 75 per cent of the stomach. As long as there is practically no acid secretion in the stomach, we are not likely to have further development of benign ulcer disease, and antrectomy with complete vagotomy apparently gives better protection than does 75 per cent resection of the stomach without vagotomy.
AN IMPROVEMENT OF 180 PER CENT IN THE FIVE-YEAR SURVIVAL RATE OF PATIENTS WITH CARCINOMA OF THE STOMACH*

Waltman Walters, M.D., and Joseph Berkson, M.D.

Rochester, Minnesota

FROM THE DIVISION OF SURGERY AND THE DIVISION OF BIOLOGY AND MEDICAL STATISTICS, MAYO CLINIC, ROCHESTER, MINNESOTA

The purpose of this paper is to report 180 per cent improvement in the outlook for five-year survival for patients receiving a diagnosis of cancer of the stomach at the Mayo Clinic. The five-year survival rate was 5 per cent in the years from 1907 to 1916, and it is estimated as 14 per cent for the period from 1940 to 1949. It should be emphasized that these percentages are on the basis of total numbers of patients with cancer of the stomach examined during these periods.

Reasons for the Improved Outlook

The reasons for this improvement in the five-year survival rate are well illustrated in Figure 1, which shows an increase in the number of patients subjected to laparotomy (60 to 80 per cent) and an increase in the number of lesions found resectable (22 to 44 per cent) from the first to the second periods. Nineteen per cent of the total patients given the diagnosis of cancer of the stomach survived resection in the early series and 40 per cent survived in the latest series. Five per cent survived five years in the early series; this rate has increased to 14 per cent for the most recent series. In 1942 when Walters, Gray and Priestley11 (and Berkson) reported on the cases of carcinoma of the stomach in which operation was performed in the period from 1907 to 1938 inclusive, the resectability rate calculated on the basis of all patients examined and given the diagnosis of carcinoma of the stomach was 25.5 per cent, but when it was calculated only for the patients operated on, it was 44.4 per cent and the hospital mortality rate was 16.2 per cent. During the 1940 to 1949 period, the surgical rate, the resectability rate and the ratio of resections to total number of patients with cancer increased progressively (Fig. 2). Total gastrectomy was reported as having been performed only 27 times before 1939, with a mortality rate of 66.7 per cent, whereas in the period from 1940 through 1950, it was performed 187 times, with an average mortality of approximately 12 per cent. (In 1945 total gastrectomy was performed in 24 cases with a mortality of 16.7 per cent, and from 1948 through 1950, in 62 cases with a mortality of 12.9 per cent.) In 1950 total gastrectomy was performed in 22 cases with a mortality of 9.1 per cent.

Many years ago Clute and Albright4 stated that there had not been a single five-year cure after total gastrectomy in more than 40 years of endeavor and probably several hundred attempts. Now there are several, and in addition, this operation has given decidedly favorable results from the standpoint of restoring health to the patient for several months or years. A recent review10 indicated that nine patients have lived more than five years after total gastrectomy performed for gastric neoplasm at
the Mayo Clinic. In December, 1948, we saw a patient on whom Priestley and one of us (Walters) had performed total gastrectomy five years and eleven months previously for carcinoma, grade III, of the stomach, with extragastric extension to the attached omentum and with one involved lymph node. This patient was in excellent condition at that time and was still living and in good health without any evidence of recurrence of carcinoma in 1951, more than eight years after operation.

There has been a progressive decline in hospital mortality rates for subtotal gastrectomy for malignant lesions of the stomach from 11.5 per cent in 1939 to 7.8 per cent in 1949.

Improvement in results of treatment of cancer of the stomach during the past ten years has been reported by others. In 1940, Pack and Livingstone reported on a collected series that the five-year survival rate of all cancer patients examined was 4 per cent, and the hospital mortality rate averaged 30 per cent. More recently, Pack reported from the gastric service of Memorial Hospital a five-year survival rate of 12.3 per cent with a mortality rate of 9.8 per cent. Boyce reported an increase of 83 per cent in the number of gastrectomies performed in the past ten years when contrasted with the preceding ten. There was also a 50 per cent reduction in the hospital mortality rates. Moreover, total gastrectomy appeared for the first time in the last ten years in the New Orleans Charity Hospital series, being performed 11 times. Unfortunately no five-year follow-up studies on longevity were reported.

Brown and Kane, in contrasting the results of operations of the Cleveland Clinic from 1940 to 1945 with those of 1950, reported an increase in resectability rates, lowered mortality rates, and an increase in the number and percentage of total gastrectomies. Here again survival rates are not reported.

Figure 3 shows the survival rates for five and ten years of our two groups of patients who survived resection. The five-year survival rate has increased from 29.2 per cent in the 1907 to 1916 series, to 34.8 per cent in the 1940 to 1949 series, and the ten-year survival period has increased from 21.7 to 26.7 per cent in the respective series. Lahey and Marshall reported in 1950 a five-year survival rate of 22.3 per cent for their patients surviving gastric resection and quoted Pack and McNier’s statistics of 34.7 per cent.

The improvement in the five and ten-year survival rates after surgical removal of lesions is due to an increase in surgical rate (patients operated on) and the resectability rate, with a decrease in operative mortality. In addition to operations of greater magnitude being done on the stomach with an increasing number of total gastrectomies, there has been an extension of the benefits of surgical intervention, particularly during the past nine or ten years, to a larger percentage of elderly patients who have had malignant lesions of the stomach. The number of patients between 70 and 79 years of age who have had gastric resections increased in the last three years over that in earlier periods, and the operative mortality, when both sexes are taken as a group, showed little change over that of patients similarly treated who were between 60 and 69 years of age (Fig. 4).
To what then can the increase in the number and the magnitude of the surgical procedures and the marked reduction of the operative risk be attributed? Undoubtedly, improvements in diagnosis, preoperative and postoperative treatment and operative technic are all important. The preoperative treatment briefly means hospitalization of the patient for a few days prior to the operation to improve nutritional status and to reduce the size of a distended stomach above an obstructing lesion, to replace fluids and electrolytes lost as a result of vomiting, and to replenish the depleted blood. These important measures, together with the great improvement in the science of anesthesiology as evidenced by the better choice of proper and effective anesthetic agents and in methods of administration, the care given to each patient's respiratory tract immediately following operation—especially bronchial aspiration, the judicious use of oxygen, the intravenous use of fluids, administration of electrolytes and blood subsequent to operation, and the administration of antibiotics when necessary to control or prevent infection—have all contributed to lower the risk of operations on the stomach. There also have been improvements in surgical technic and in surgical treatment.

If in every surgical case the surgeon will carry on with the idea that a certain procedure, for example, resection, can be done, that this is the only procedure indicated, and that it will be done unless there are absolute and positive contraindications to it, it is surprising how many times a lesion which at first seems to be inoperable, can be removed. In other words, with the recognition that total gastrectomy can always be done unless the lesion has penetrated beyond the stomach to vital structures that cannot be removed, we think that not only more total gastrectomies, but also more subtotal gastrectomies will be performed.

To us it appears likely that the surgeon will extend the field in which he plans to use subtotal gastrectomy, since he knows that if a sufficient amount of stomach is not available for anastomosis to the intestine after adequate gastric resection, total gastrectomy can be done with almost equal facility, and sometimes even more facility. It is hardly necessary to say that as wide a resection as possible should be done. It should extend as low as possible on the duodenum and at least 5 cm. above or proximal to the final proved extension of the lesion.

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lesion. (The extension of the lesion should be proved by immediate microscopic examination of frozen sections before the operation is complete.) All the attached gastrohepatic and gastrocolic omentum containing the perigastric lymph nodes should be removed; the latter should be dissected from the colon. Gastric resections of this magnitude will and have improved the results of the operation measured in years of life.

SURVIVAL IN RELATION TO ABSENCE OR PRESENCE OF METASTASIS

In the further discussion of survival rates, it is interesting to note that for data on malignant lesions of the stomach published in book form in 1942, more than 99 per cent of the patients were traced for more than five years and more than 98 per cent of the eligible patients for more than 20 years. This percentage has now increased to more than 99. After resection of stomach for malignant lesions for all patients so treated from 1907 to 1949, it is estimated that 31.6 per cent will be living five years after operation, 23.2 per cent ten years after operation, 17.2 per cent 15 years after operation, and 12.2 per cent 20 years after operation.

After a five-year period, this survival rate practically parallels the survival rate of the normal population (Fig. 5). The relation of presence or absence of metastasis is shown in Figure 6. Of the patients who underwent gastric resection but did not have metastasis, 48.5 per cent will be living five years after operation. Unfortunately the presence of metastasis reduces the survival rate to only 18.6 per cent. In this connection, however, it is interesting to note that the complete removal of areas of extension to adjacent structures with the involved portion of stomach has given almost as good results as if such extension had not occurred.

SURVIVAL RELATED TO GRADE OF MALIGNANCY

The accuracy of Broders' histologic grading of malignancy as an index of longevity of life is well illustrated in Figure 7, which shows a 56.8 per cent five-year survival rate after resection for malignant disease of the stomach of grades I and II. Moreover, it shows that even in the presence of grade IV lesions, a reasonably optimistic viewpoint can be maintained, for 22.8 per cent were alive at the end of five years after resection, and from then on the longevity practically parallels that of the grades I, II and III.

FUTURE IMPROVEMENT OF RESULTS

How are we going to improve the results of treatment of cancer of the stomach in the future? In a recent symposium on ad-
advances in cancer therapy, Comfort commented: "A casual attitude toward known precursors of cancer of the stomach must be decried. Adenomatous gastric polyps seem unquestionably a precursor of gastric cancer. In a recent study of 185 cases of pathologically verified adenomatous gastric polyps by Cromer, Butt and Comfort, the polyp was benign in 150 and malignant in 35 (more than 20 per cent). Gastric polyps require removal. Regardless of opinions about the change of a benign ulcer to a malignant one, it is clearly established that about 10 per cent of gastric ulcers, surgically and nonsurgically treated, are malignant." In the experience of one of us (Walters) this has been nearer 20 per cent.

Comfort also stated: "The responsibility assumed by any physician who elects to treat a gastric ulcer medically when resection is available at a risk of 1 to 2 per cent has been emphasized repeatedly.

Cancer detection clinics are serving a useful purpose, chiefly in the education of the public and the profession. A high degree of suspicion on the part of every physician should accomplish more in early diagnosis than do these isolated groups. Chairs of oncology currently being established in our medical schools will give basic information to medical students about the cancer problem.

Finally, methods of therapy other than surgical methods have been examined, but to date none has appeared to be of great value in the treatment of the patient who has gastric cancer. More fundamental knowledge of the cause of cancer may necessarily precede the development of such methods."

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**Fig. 6.—Survival rates of patients who underwent gastric resection showing influence of metastasis.**

**Fig. 7.—Survival rates of patients who underwent gastric resection by grade of malignancy of lesion.**

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**SUMMARY**

The surgical rate and the resectability rate, in cases in which a diagnosis of cancer of the stomach has been made, have increased greatly since 1916. In addition, there has been a marked increase in the number and relative percentage of cases in which total gastrectomy is employed together with a decreasing mortality rate, especially during the past ten years. These changes have increased the survival rate in terms of all patients with cancer of the stomach examined at the Mayo Clinic from 1940 to 1949, so that it is estimated as 14 per cent in contrast to 5 per cent from 1907 to 1916.

The five-year survival rate after gastric resection has increased from 29.2 per cent in the 1907 to 1916 series to 34.8 per cent in the 1940 to 1949 group, and the ten-year survival rate from 21.7 to 26.7 per cent.
The resectability rate was 25.5 per cent when calculated on all patients with cancer of the stomach examined from 1907 to 1938 inclusive, at the clinic. This increased to 44 per cent in the 1940 to 1949 series.

There has been a drop in the mortality for subtotal gastric resection for cancer to 7.9 per cent in 1951 and in 62 cases of total gastrectomy for 1948 to 1950 to 12.9 per cent. Even with these operations of greater magnitude, 40 per cent of the total number of cancer patients examined survived gastric resection or total gastrectomy in the 1940 to 1949 series in contrast to 22 per cent in the 1907 to 1916 series.

Further improvements in longevity statistics doubtless will depend on earlier recognition of the presence of the malignant gastric lesion and getting the patient into the hands of the surgeon when the lesion is still resectable.

BIBLIOGRAPHY


Discussed.—Dr. ALFRED BLALOCK: I really should not discuss this paper without any figures to corroborate what I have to say, and I do so solely because on several occasions in this meeting it has seemed to me that perhaps the resident staff has not quite received due credit for what they are doing. For example, I refer to the discussion of Dr. Boyce’s paper. As I say, I do not have our figures, but I know that in our hospital, total gastrectomy had a terribly high mortality until a couple of residents came along who had a particular interest in the procedure and immediately the mortality dropped, and dropped tremendously. And I think that our figures are as good as those of Waltman Walters or of Dr. Lahey or of others.

My sole reason for rising is to say that if the Residency Training Program is properly conducted, if candidates are chosen wisely and then given a graduated responsibility in the care of patients, those patients will be looked after just as well as though they were being looked after by Waltman Walters, or Dr. Lahey or other eminent members of this Association. I do not want to see the residency staff underrated, because I think if properly chosen, brought on gradually, and given graduated responsibility, their results are as good as those of the Senior Staff. I wish to repeat that we have had the same experience that Dr. Walters has reported in his treatment of carcinoma of the stomach and, in our own case, the advance has been due largely to the resident staff.

Dr. M. E. De Bakey, Houston, Texas: I do not want to belabor the point Dr. Blalock made, but I think it is sufficiently important to deserve additional emphasis. Our experience has been much
the same as that described by Dr. Blalock. To illustrate this, I should like to refer to some figures which we have recently obtained from an analysis of our experience with perforated ulcer. Approximately a year ago we adopted the policy of doing immediate gastric resection, or at least delayed gastric resection, in the treatment of perforated gastroduodenal ulcer. Our results prior to the adoption of this policy in the management of perforated ulcer, even by the conservative procedure of simple closure, showed the mortality to be about 12 per cent. Many of these patients were cared for by our visiting staff. During the past year, since adopting the policy of doing gastric resection as the treatment of choice, almost all these patients have been operated on and cared for by our surgical resident staff. We have now done a consecutive series of 48 cases with one death and with no serious complications. The single death was a patient with cardiac arrest. I believe that this significant reduction in mortality to approximately 2 per cent in the treatment of perforated ulcer is a good illustration of the point Dr. Blalock has made.

There is one other point I would like to emphasize in connection with Dr. Walters’ data. You will recall that one of the slides he showed revealed an increase in resectability of approximately 100 per cent in the more recent series. I believe this factor played a highly important role in increasing the incidence of five-year survivals. I do not wish to depreciate the factor he brought out so well of increasing the extent of the operation, but in almost any form of cancer surgery the most important factor influencing the results of treatment is the incidence of resectability. The five-year survival rate will usually show a straight line relationship to this factor.
THE RELATION OF GASTRIC ULCER TO CARCINOMA OF THE STOMACH*

SAMUEL F. MARSHALL, M.D.

BOSTON, MASSACHUSETTS

DEPARTMENT OF SURGERY, THE LAHEY CLINIC, BOSTON, MASSACHUSETTS

MALIGNANT DEGENERATION of a benign gastric ulcer has, for many years, been considered a frequent occurrence by many surgeons and internists who have had to treat these problems. Absolute positive evidence that a gastric ulcer may become malignant or may undergo malignant degeneration is difficult to prove histologically. Shields Warren states that in their material at the Pathological Laboratory, where all of the Lahey Clinic's resected gastric specimens are studied histologically, there have been only four such cases in which evidence was found that cancer probably arose on the basis of pre-existent benign gastric ulcer. Meissner, of Warren's Laboratory, makes the statement that many gastric carcinomas are superficial, particularly in their early stages, and may undergo central peptic ulceration—thus giving a pathologic picture of both ulcer and cancer. Only when there is evidence of long-standing destruction and fibrosis of the stomach wall associated with cancer can one be suspicious of cancer arising from chronic ulcer; even here, it is difficult to prove that the long-standing disease was not a long-standing cancer. The diagnosis of carcinoma arising from benign chronic peptic ulcer, therefore, must be made with extreme caution pathologically and only when clinical and radiologic impressions are consistent with the pathologic changes.


Bockus is of the opinion that carcinoma of the stomach and peptic ulcer are distinct diseases, and that malignant degeneration does not occur in a gastric ulcer as often as had been anticipated, especially considering the high rate of gastric carcinoma in the population as a whole.

Mallory, in 1940, gave an excellent discussion of malignant degeneration of gastric ulcers and concluded that clinical statistics for the most part agree that chronic gastric ulcer rarely becomes carcinomatous and emphasized that the greatest caution is necessary in the effort to interpret from the histologic picture the origin of a malignant ulcer.

The difference in the tendency of gastric and duodenal ulcers to undergo malignant degeneration has been cited frequently as an important difference in these two ulcers. Malignant degeneration of a duodenal ulcer, for practical purposes, is rarely, if ever, seen. In the history of this clinic we have not had evidence that a single duodenal ulcer became malignant. Inasmuch as the histologic proof of such malignant degeneration in a gastric ulcer is wanting or is equivocal, much of the data supporting such conclusions have had to be based upon clinical material. Ewing stated that malignant degeneration rarely occurs in a gastric ulcer and that such origin of malignant ulcer probably accounts for not more than 2 or 3 per cent of the gastric carcinomas; however, on the basis of clinical material, the incidence of malignancy in what was thought to be a gastric ulcer, as
proved by operation and pathologic examination, has varied from 10 to 20 per cent (Table I). Most of these were probably malignant from the beginning. This is a much more conservative and probably more accurate estimate when compared with the earlier figures of such malignancy in gastric ulcer, as in Wilson and MacCarty's report in 1909 which gave the incidence as 71 per cent. In 1924, Finsterer stated that malignant degeneration of a benign ulcer occurred so frequently that resection of a gastric ulcer may be regarded as an early operation for cancer of the stomach. Such opinions of the high incidence of malignant degeneration in gastric ulcer have undergone considerable change in the last half century, and clinical evidence seems to support the conclusion that approximately 10 to 15 per cent of ulcers that appear benign grossly on roentgenologic and clinical examination, prove to be malignant on microscopic examination. Swynnerton and True-love in 1951, in a study of 375 cases of proved carcinoma, concluded that there was evidence that benign ulcers preceded malignancy in a high percentage of cases and cited 26 cases in this group in which there was some evidence that the neoplasm may have arisen on a simple ulcer. There was, however, no unequivocal histologic evidence for such a conclusion.

Ekström, in a review of this problem, stated that in 16 of 138 radical gastric resections, histologic study gave evidence that carcinoma had arisen from a chronic gastric ulcer. This is a very high estimate and, again, difficult to prove histologically.

Table I gives the incidence of malignancy in gastric ulcer as proved by operation and microscopic examination in a series of cases over the past 30 years. The figures vary between 10 and 20 per cent.

The substance of this paper consists of a report of 411 consecutive cases of gastric ulcers (Table II) that came to surgery because malignant disease could not be excluded clinically or because the ulcer recurred or failed to heal. Table III gives the indications for operation in a group of 346 benign ulcers and in 65 malignant ulcers proved by histologic examination. It will be evident at once that 95 per cent or more of the cases of what has been called malignant ulcer (65 in this series) are, in reality, cancerous at the onset and that this becomes a problem of discussing early diagnosis of cancer, rather than discussing the question of malignant degeneration on a benign ulcer. The subject appears in quite a different aspect when considered from this point of view.

No completely reliable clinical data are available at present to distinguish all cases of benign ulcer from malignant gastric ulcer. Such differentiation must be made by pathologic examination after removal of the tissue. With the present methods of clinical diagnosis, it is utterly impossible to make an accurate diagnosis in many of these cases, which accounts for the high incidence of gastric malignancy found at the operating table in so-called gastric ulcers. It should be pointed out, however, that these do not constitute diagnostic errors, since the majority of these patients are submitted to surgery because of the impossibility of excluding carcinoma. In this series of 411 gastric ulcers, carcinoma could not be excluded preoperatively in 195 of 411 cases operated upon (Table III and IV).

The difficulty of excluding cancer in gastric ulcers is further evidenced by the fact that a definite diagnosis of carcinomatous ulcer was made preoperatively in 44 patients of the group of 346 cases of pathologically proven benign ulcers (Table I). It may be noted also in the group of 65 cases of malignant ulcers that a diagnosis of cancer was made preoperatively in one patient (Table IV) which at operation proved to be malignant. This case must be included in this ulcer series, since a clinical diagnosis of benign ulcer was made and this patient...
was treated for two and a half years prior to the diagnosis of malignant ulcer made immediately before operation.

It is our opinion, therefore, that there is not enough histologic evidence to warrant a conclusion that many carcinomas develop from a benign gastric ulcer, and it is improbable that such an origin accounts for a large proportion of gastric cancer, probably only 5 per cent. Wangensteen has pointed out that the mortality following gastric resection for benign gastric ulcer is very small, probably less than 5 per cent. In our hands it has been 2.2 per cent, but the mortality from unrecognized gastric cancer treated medically is 100 per cent. This is a most important consideration and the physician assumes a very serious responsibility to the patient when he advises continued medical treatment in the management of a chronic recurrent ulcer. A very practical consideration is that an ulcerocarcinoma may be mistaken for a benign ulcer. This cannot be laid at the door of diagnostic error, but is due to the fact that it is impossible clin-
nancy and, although these clinical data are not completely reliable, the physician must be aware that cancerous ulcers may improve clinically on medical management and even show a moderate degree of healing, but never completely disappear under such treatment. Eusterman suggested that the recent onset of an ulcer, the large size of the lesion, the location (greater curvature or prepyloric area), progressive clinical course, histamine-fast achlorhydria, prepyloric obstruction and persistent occult blood in the stool with increase in the size of the lesion while under treatment are strong evidences of the possibility of malignant degeneration or of the presence of an ulcerocancer. Such clinical findings would certainly warrant early operation in many patients.

The only safe course to follow in medical treatment of a gastric ulcer is to insist upon complete healing of an ulcer at the completion of an adequate period of controlled medical therapy. Patients with malignant gastric ulcers under medical therapy not only improve symptomatically, but often may become symptom free. A malignant ulcer may decrease markedly in size but will not completely disappear, and all of these patients with ulcers that fail to heal under good medical management must be operated on early.

Malmros and Hierton, in an investigation of 687 medically and surgically treated cases of peptic ulcer (192 gastric ulcers), found only 12 cases of carcinoma at operation and at postmortem. The majority appeared so early that it was possible that the diagnosis of gastric ulcer was incorrect from the beginning. They thought that the risk of malignant degeneration in a gastric ulcer was so slight that it need hardly be taken into consideration. Here again the observers are considering solely the problem of malignant degeneration, and not the more important aspect of unrecognized ulcerocancer.

Allen, in an editorial in 1951, emphasized that gastric ulcer visible on the roentgenogram and characteristic in every way of a benign ulcer may prove to be cancer in at least 10 per cent of all cases. This simple fact is of considerable practical importance in the continued medical and dietary control of a chronic recurrent gastric ulcer. There is ample evidence at hand to suggest that healing of a benign gastric ulcer is often incomplete. It is exceedingly important that these patients be followed at intervals, not only for supervision of their medical therapy, but also to obtain repeated roentgenograms and even gastroscopic examination to be sure that the ulcer has remained completely healed or that it has recurred.

In our experience in this clinic, gastric ulcers have occurred in the ratio of one gastric ulcer to 12 duodenal ulcers. Approximately 37 per cent of our patients with gastric ulcers have been treated surgically. It is of interest to note the coexistence of a duodenal ulcer and gastric ulcer. Bockus has made the statement that patients with duodenal ulcer who have marked gastric hyperchlorhydria rarely die of gastric carcinoma. Carcinoma is less likely to develop in patients with duodenal ulcer and coexistent

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<th>TABLE I.—Incidence of Malignancy in Gastric Ulcer Proven by Operation and Pathologic Examination.</th>
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<td>Morley (1923).................................................. 10.0</td>
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<td>Finsterer (1939)................................................. 20.9</td>
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<td>Allen and Welch (1941).............................. 14.0</td>
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<td>Marshall and Welch (1948)............................. 19.8</td>
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<td>Lampert, Waugh and Dockerty (1950).................. 13.0</td>
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<td>Ekström (1952).................................................. 11.6</td>
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<td>Marshall (present series).............................. 15.8</td>
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<td>Eusterman (1946).............................................. 13.4</td>
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<th>TABLE II.—Gastric Ulcer. 411 Operated Cases.</th>
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<td>Benign ulcer........................................ 346 84.2</td>
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<td>Malignant ulcer....................................... 65 15.8</td>
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RELATION OF GASTRIC ULCER TO CARCINOMA OF STOMACH

...gastric ulcer than in those who had no stomach disease. Fischer et al. in 1947, reported 48 proven cases of gastric malignancy coexistent with duodenal ulcer and concluded that such an existence was rare, tro-enterostomy was done for gastric ulcer, in 41 for duodenal ulcer and in one for other reasons. Rivers and Stauffer reported the incidence of coexistence of gastric and duodenal ulcer as 8 per cent.

Fig. 3.—Man, age 68 years. (A) Benign ulcer on the greater curvature of the stomach; constant filling defect with demonstrable crater and diminished flexibility of gastric wall can be seen. Insert shows penetration of gastric wall. Preoperative diagnosis was carcinoma. (B) Specimen removed at operation; arrows indicate ulcer.

...that the probability of coexistent gastric carcinoma and duodenal ulcer was one in 938 and that a patient with duodenal ulcer has relatively good assurance that the possibility of malignant development in a gastric ulcer is slight. The incidence of coexistence of duodenal ulcer and gastric ulcer in our series of 411 cases was 9 per cent. It is also of interest to note that Gray and Lofgren, in a review of 53 patients with lesions in the stomach after gastro-enterostomy, found that 18, or 34 per cent, had cancer. In 11 of the 53 cases, the surgical cure is not possible in a large percentage of cases of gastric carcinoma by the time patients seek medical advice, early and accurate distinction between benign and cancerous lesions is of paramount importance if the results of surgery for gastric ulcer are to be improved. However, Kirsner has pointed out that the problem of survival in gastric cancer is not entirely a matter of earlier diagnosis or radical surgery, although these factors are of considerable importance. The biologic nature of any gastric carcinoma cannot be...
evaluated or the rate of growth determined, which is likewise of considerable importance in prognosis after surgical treatment.

Kirsner is of the opinion that the roentgen ray is the most important single diagnostic method for the recognition of benign and malignant gastric ulcer. Gastroscopy has been helpful in our hands, but has not often made possible the accurate differentiation between a benign and malignant lesion. It has aided, however, in determining whether healing after treatment is complete. The histologic method of Papanicolaou may prove to be more promising, particularly with the newer balloon abrasive technique, as suggested by his group.

When a diagnosis of gastric ulcer is made roentgenographically, it is important that the clinician and the roentgenologist weigh their clinical and roentgen information and make a decision as early as possible regarding the type of treatment to be employed. Both should follow the case closely and frequently until it is proved that the ulcer has healed and disappeared, or has failed to heal (Fig. 1) or has recurred, with surgical intervention being utilized promptly, since there is still a 10 to 20 per cent chance that the ulcer is malignant. Kirklin has stated that the important roentgenologic characteristic of benign ulcer is the projection of the ulcer niche beyond the normal wall of the stomach, as the crater of a true ulcer. This can also occur in malignant ulcer (Fig. 2). On the other hand, small, ulcerating carcinomas have the characteristic that the excavation does not extend into the gastric wall and the ulcer niche does not go beyond the normal limits of the gastric lumen.

Palmer pointed out that there are many pathognomonic signs of malignant disease in an ulcerating gastric lesion, but there are no pathognomonic criteria that the ulcer is benign. It is important, therefore, to emphasize that if the physician recommends medical management, the course of treatment of the gastric ulcer must be followed by repeated roentgenologic and gastroscopic examinations. The only reliable data of a healing benign ulcer are the absence of occult bleeding, progressive decrease in size of the ulcer with disappearance, and complete healing of the crater as evidenced by roentgenologic and gastroscopic examinations. The physician must be certain that such patients are examined every two months for a minimum of six months. If the ulcer recurs, surgical resection is an absolute necessity in view of the evidence that 10 to 20 per cent of all cases of gastric ulcer are malignant.

There are no signs or symptoms that can be said to be typical of benign or malignant ulcer; the size of the ulcer, its site of origin, the age of the patient and the level of gastric acids give little reliable information regarding the presence or absence of malignant disease in these gastric ulcers.

In this study of 411 patients with gastric ulcer, it is of interest to note the similarity in the sex incidence. In the group of 346 patients with benign ulcer, the ratio was 2.7

**TABLE III.—Indications for Operation in 346 Cases of Benign Gastric Ulcer.**

<table>
<thead>
<tr>
<th>Indications for Operation</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carcinoma ..................</td>
<td>44</td>
</tr>
<tr>
<td>Unable to exclude carcinoma.</td>
<td>113</td>
</tr>
<tr>
<td>Recurrence of gastric ulcer</td>
<td>110</td>
</tr>
<tr>
<td>Failure to heal ............</td>
<td>49</td>
</tr>
<tr>
<td>Pyloric obstruction ........</td>
<td>18</td>
</tr>
<tr>
<td>Hemorrhage ................</td>
<td>9</td>
</tr>
<tr>
<td>Incidental finding at laparotomy</td>
<td>2</td>
</tr>
<tr>
<td>Perforation ................</td>
<td>1</td>
</tr>
</tbody>
</table>

**TABLE IV.—Indications for Operation in 65 Cases of Malignant Gastric Ulcer.**

<table>
<thead>
<tr>
<th>Indications for Operation</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carcinoma ..................</td>
<td>1*</td>
</tr>
<tr>
<td>Unable to exclude carcinoma.</td>
<td>37</td>
</tr>
<tr>
<td>Recurrence of gastric ulcer</td>
<td>17</td>
</tr>
<tr>
<td>Failure to heal ............</td>
<td>5</td>
</tr>
<tr>
<td>Obstruction ................</td>
<td>5</td>
</tr>
<tr>
<td>Hemorrhage ................</td>
<td>0</td>
</tr>
</tbody>
</table>

*Roentgenogram evidence and treated for gastric ulcer for 2½ years.
RELATION OF GASTRIC ULCER TO CARCINOMA OF STOMACH

males to 1 female (Table V). The same ratio held as far as malignant ulcer is concerned, 2.8 to 1. This closely approximates the sex ratio noted in gastric carcinoma, which in our study of 1600 cases of carcinoma was 2 to 1.

The youngest patient with a malignant ulcer was 20 and the oldest was 79 years. The youngest patient with a benign ulcer was 26 and the oldest was 82 years of age (Table VII).

The location of the ulcer is of some importance in distinguishing between benign and malignant ulcers of the stomach, but it must be emphasized that either type will occur in any part of the stomach. As noted previously, Eusterman thought that location of an ulcer on the greater curvature or prepyloric area indicated a high probability of the presence of a malignant ulcer (Figs. 3, 4 and 5). Swynnerton and Truelove are of the opinion that ulcers of the prepyloric region are extremely likely to become malignant. Although ulcers located in these regions should be looked at with considerable suspicion, such a location is by no means evidence of their benignity or malignancy (Fig. 6). Stewart,25 in 1929, in a study of 4000 consecutive necropsies at Leeds General Infirmary, found chronic

It is well known that gastric ulcer occurs more frequently in men than in women, and this is true of gastric carcinoma. Dible3 stated that 72 per cent of gastric ulcers occur in the male, while Walters and Clagett28 found that of 272 patients operated on for gastric ulcer, 80.9 per cent were men. In our series there were 297 males (72 per cent) and 114 females.

The average age of patients with gastric ulcer is similar to that of patients with gastric carcinoma. Age incidence in this group is given in Table VI. The average age of patients with benign gastric ulcer was 53 years and with malignant ulcer, 53.5 years. The average age of patients in the series of 1600 gastric carcinomas was 57 years. The
gastric ulcer in 9.55 per cent; 51.5 per cent were within 5 cm. of the pyloric ring and there were 14 benign ulcers on the greater curvature. Portis and Jaffe, in a study of peptic ulcer based on necropsy records, found 59 per cent of the ulcers within 5 cm. of the pyloric ring. Figures 7 and 8 give the location of the gastric ulcers, both malignant and benign, in this series; in the group of 346 cases of benign ulcers, 32 per cent were within the prepyloric area and 10 were on the greater curvature.

Although this series of malignant gastric ulcers is small, we believe it is of some significance that nearly half (44.5 per cent) of the malignant ulcers were in the prepyloric area. There were only two cases in which the malignant ulcers were on the greater curvature. On the other hand, ulcers on the greater curvature are not as common as we are led to believe. We agree that a patient with a prepyloric ulcer should be observed very closely under treatment, and in the majority of cases should have surgical treatment, yet in our series the incidence of malignant ulcer in this region was not much greater than the incidence of benign ulcer, 44.5 to 32 per cent. It must be remembered, however, that gastric carcinoma arises in this region more commonly than in any other part of the stomach, and serious consideration should be given to this fact. It is significant that the majority of benign ulcers occur on the lesser curvature of the stomach; this origin very properly suggests a benign ulcer and warrants medical therapy unless roentgenologic or gastroscopic evidence is to the contrary. In this group of
46 cases of benign ulcers, 64 per cent were located on the lesser curvature, and yet 43 per cent of the malignant ulcers also were in this region. It is also significant and important to point out that while the criterion suggested by Kirklin of projection of the ulcer crater beyond the normal boundary of the gastric walls indicates a benign ulcer, this occurred in an appreciable number of our malignant ulcers. The meniscus sign of Carman frequently has indicated a malignant ulcer.

The size of the ulcer is of some importance. Benign ulcers can be quite large; frequently a benign lesion is greater than 2.5 cm. in diameter. In Table VIII a summary is given of the size of benign and malignant ulcers as found on pathologic examination. It has been thought an ulcer larger than 2.5 cm. in diameter strongly indicates malignancy. In our group of malignant ulcers 49.2 per cent were larger than 2.5 cm., whereas in the benign group (Table VIII; Fig. 9), 22 per cent were larger than 2.5 cm. The smallest malignant ulcer noted at operation was 7.5 mm. in diameter, and the smallest benign ulcer was 8 mm. in diameter. Although the size of the ulcer and its location are of some help in determining the presence or absence of malignant disease, these factors are by no means dependable criteria of the presence of carcinoma or of a malignant ulcer.

A study of duration of symptoms has been of no value in differentiating malignant and benign ulcers. In the group of 65 patients with malignant ulcers, only 31 per cent had symptoms for one year or less, whereas 69 per cent had symptoms for more than one year and 49 per cent had ulcer-like distress for five years or longer. It cannot be concluded that in this group of patients with symptoms for five years or longer, carcinoma developed in a long-standing ulcer, because we lack proof that an ulcer was present, and their digestive symptoms may well have been due to other causes. Likewise, 45 per cent of patients with benign gastric ulcers had symptoms for one year or less and of the remaining patients who had symptoms for more than one year, 30 per cent had digestive symptoms for five years or longer.

Clinical differential diagnosis is of considerable importance, but the only reliable criteria of the true nature of a gastric lesion is a pathologic examination of the removed ulcer, which presents the only definite evidence of a benign or malignant lesion. However, to submit every patient with a gastric ulcer to surgery would result in many patients with benign lesions having unnecessary operative procedures. In our experience in the clinic, 37 per cent of our patients with gastric ulcers have had surgical treatment; we believe, however, that a larger group should have surgical treatment. By far the larger group has been treated conservatively and, in most instances, successfully by dietary and medical methods. The therapeutic test of adequate

### Table V.—Sex Incidence in 411 Operated Cases of Gastric Ulcer.

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benign ulcer</td>
<td>249</td>
<td>97</td>
<td>346</td>
</tr>
<tr>
<td>Malignant ulcer</td>
<td>48</td>
<td>17</td>
<td>65</td>
</tr>
<tr>
<td>Total</td>
<td>297</td>
<td>114</td>
<td>411</td>
</tr>
</tbody>
</table>

| Ratio: Male to female | Benign ulcer: 2.7 to 1 | Malignant ulcer: 2.8 to 1 |

### Table VI.—Age Incidence in 411 Operated Cases of Gastric Ulcer.

<table>
<thead>
<tr>
<th>Age by Decades, Years</th>
<th>Benign Ulcer, Cases</th>
<th>Malignant Ulcer, Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>20–29</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>30–39</td>
<td>43</td>
<td>6</td>
</tr>
<tr>
<td>40–49</td>
<td>81</td>
<td>13</td>
</tr>
<tr>
<td>50–59</td>
<td>135</td>
<td>26</td>
</tr>
<tr>
<td>60–69</td>
<td>71</td>
<td>17</td>
</tr>
<tr>
<td>70–79</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>80</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>346</td>
<td>65</td>
</tr>
</tbody>
</table>
medical treatment in the hospital is of considerable value and helps immeasurably in making a decision for or against surgery—whether surgery is necessary or medical treatment should be continued—but this decision should be made much earlier than it has been and preferably while the patient is still in the hospital. It should not be deferred until the patient has been treated repeatedly for recurrent symptoms.

Patient should be operated on immediately in the vast majority of cases, that is, unless his general physical condition makes operation hazardous. The danger of overlooking gastric carcinoma and the risk of surgical intervention must be weighed most carefully. Should the ulcer fail to heal while the patient is in the hospital, that patient should have surgical treatment, usually gastric resection.

We believe that if there is any question whatever concerning the presence of gastric malignancy, that patient also should be operated on while in the hospital. Walters\textsuperscript{57} has made the statement that all patients more than 40 years of age who have chronic, recurring gastric ulcers should have surgical treatment because of the danger of malignancy, because of the low operative risk rate and the excellent results following operation. We are in complete agreement with such a method of treatment. Our experience with this series of 411 cases of gastric ulcer has emphasized the need for surgical treatment in almost half of the cases studied.

Should the ulcer fail to heal, should it recur or should we be unable to exclude malignant disease, operation must be em-
employed as soon as possible, and in the majority of cases this should be gastric resection provided the patient's condition permits a radical procedure. A gastric ulcer high on the lesser curvature has always presented a somewhat difficult problem to the surgeon because of its height and location, and if the ulcer is large and extensive, a total gastrectomy may be required. However, ulcers near the esophagogastric junction can be resected in a large percentage of cases without performing total gastrectomy. When the gastrohepatic omentum is detached, frequently there is sufficient room above the ulcer to permit resection of the stomach and removal of the ulcer without encroachment upon the esophagogastric junction. Whether the ulcer is too high to permit partial gastrectomy cannot be determined solely from the roentgenogram. This can be determined only at the operating table when the stomach is completely mobilized and the relationship of the ulcer to the esophagus is clearly delineated.

In 13 patients, however, total gastrectomy was done for benign ulcerating lesions of the stomach (Fig. 5). The only death occurred in a patient with a huge perforated ulcer which was thought to be carcinoma and upon whom a total gastrectomy was done as an emergency measure. Adequate follow-up data are now available in all 12 of the patients who had total gastrectomy and excellent results were obtained in all of these cases.

The mortality in this series of 411 cases was 2.2 per cent. There were eight deaths in the group of 346 patients with benign ulcers, a mortality of 2.3 per cent, and one death in the group of 65 patients with malignant ulcers. The resection of a gastric ulcer is a much easier procedure than resection of a duodenal ulcer. The technical details of resection of a gastric ulcer are much less involved than of a duodenal ulcer, and the mortality conceivably can be extremely low. The technical difficulties of duodenal transection and closure for gastric ulcer are much less than for duodenal ulcer. The mortality in duodenal ulcer is largely related to the degree of involvement by the ulcer of the head of the pancreas and of the common bile duct. The induration often makes anatomical dissection hazardous and the closure of the duodenum at times may be very difficult. The mortality following resection of gastric ulcer as given in the literature varies from 2 to 5 per cent.

We do not believe that vagotomy should be employed in the treatment of gastric ulcer, with the rare exception of a case in which resection is contraindicated because of the patient's condition or because the ulcer is high in the lesser curvature. Even in these cases the ulcer should be excised locally in order to obtain reliable histologic evidence of the absence of a carcinoma in the ulcer. However, it is our opinion that a partial gastric resection carries as small a risk as that associated with vagotomy and local excision of the ulcer, and is a preferable surgical procedure. Patients with gastric ulcer who are treated in the hospital by dietary and medical methods should remain in the hospital at least three weeks. In Smith and Jordan's report of a group of 600 patients treated medically and surgically, 145 patients were under treatment and observed frequently by roentgeno-
grams; healing was noted to be complete in 84 cases within four weeks and in 52 cases within five to eight weeks. Smith and Jordan suggested that healing should be complete within six to eight weeks in all patients. Unless one can be assured that the ulcer healing is a progressive process and results in complete healing, surgical resection is an absolute necessity.

Postoperative results, in general, are excellent; mortality can be kept at a minimum, clinical results are extremely satisfactory and recurrent ulcer after resection is infrequent; to our knowledge, a recurrent ulcer has not developed in any of these cases, although the follow-up period in some cases is too brief to evaluate. No cases are included in this report in which operation was performed later than 1951.

**SUMMARY**

A group of 411 consecutive cases of gastric ulcer in which surgical resection was performed is reported. The incidence of malignant ulcer in this group was 15.8 per cent.

It is our opinion that there is insufficient histologic evidence to warrant a conclusion that gastric ulcers present a high potential origin for malignancy. Unquestionably, secondary malignant degeneration does occur on a chronic gastric ulcer, but probably in not more than 5 to 6 per cent. A more practical assumption in this problem is that an ulcerocarcinoma may be mistaken for a benign ulcer, and continuation of medical therapy may result in dangerous delay of treatment of gastric malignancy.

Clinical data will enable the physician to recognize the probability of malignancy or benignity in a large percentage of cases but will not exclude cancer in a considerable number of these patients.

Adequate medical treatment in the hospital is a valuable therapeutic test and should be used in a large number of these patients, particularly in patients who have not had adequate medical treatment and who have none of the diagnostic signs of an ulcerocarcinoma.

If healing of the ulcer is not progressive or complete, surgical treatment is mandatory.

Clinical criteria, such as size of ulcer, location of lesion, age of the patient and history, are not completely reliable and if malignancy cannot be excluded by all methods of examination, including a therapeutic trial, surgical intervention is an absolute necessity.

The routine surgical treatment of all cases of uncomplicated gastric ulcers is not recommended and is undesirable; in a considerable percentage of cases it cannot be
regarded as a prophylactic measure against the development of carcinoma of the stomach. We do not advocate or advise immediate operation in every case of gastric ulcer, but it is our opinion that a higher percentage, probably 50 per cent or more, of chronic gastric ulcers should be resected, since an appreciable number (15.8 per cent) have been found at operation to be malignant. Temporizing with a nonhealing, ulcerating lesion of the stomach involves serious risk to the patient and is completely unjustified.

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GASTRIC ULCER AND GASTRIC CANCER*
I. S. Ravdin, M.D. and Robert C. Horn, Jr., M.D.

PHILADELPHIA, PENNSYLVANIA


RESECTION of the stomach and the contiguous omenta is, at present, the only therapeutic method which offers hope in gastric cancer. The best end results following resection are obtained when the gastric malignancy has been found to be limited to the stomach and has not extended to a single perigastric lymph node. Under these circumstances, hope for five-year survival is approximately 50 per cent. When a single node is involved at the time of resection, the number of patients living and well at the end of five years falls sharply, so that in general, the end results are poor. Far too often the resection is an operation of palliation from the beginning.

It is an unfortunate circumstance that gastric and duodenal ulcers have been grouped under the general term of peptic ulcer. Duodenal cancer is exceedingly rare. Gastric cancer is exceedingly common. The grouping of duodenal and gastric ulcer under the term peptic ulcer has long indicated in the minds of internists, gastroenterologists and general practitioners that these lesions have a common etiology and a common life history. The accuracy of either statement is actually in doubt.

It is frequently impossible, even for the most skilled roentgenologist, to distinguish between a benign and a malignant gastric ulcer. The size of the ulcer is now agreed to be of little diagnostic help. The position of the ulcer is of very limited diagnostic value. Roentgen evidence of healing, as evidenced by the subsequent filling of the defect, cannot be accepted as proof of benignancy for in certain instances, such a circumstance is associated with actively growing cancer cells filling a previously demonstrated crater.

The gastric acid curves are at most only suggestive and rarely truly diagnostic. The same is true for other gastric secretion studies. We have had a tendency for too long to place too much reliance on studies of this type.

We have had so many failures to diagnose an early malignant lesion of the stomach by gastroscopy that we have all but discarded it as a very important method of diagnosis. The study of cells, which have been obtained by mechanical gastric surface defoliation and lavage, now offers real promise; however, at this time in very early gastric cancer too great reliance cannot be placed even on this method in the great majority of our laboratories.

All too frequently gastroenterologists and internists indicate to the patient that it is safe to try several periods of medical therapy because they are reasonably sure that the lesion is a benign one; this in spite of the fact that the most experienced gastrointestinal surgeon is very often unable to tell with accuracy whether the lesion is benign or malignant even after he has ex-
posed and palpated the lesion. Position, size and the presence or absence of lymphadenopathy, or even induration of the gastric wall surrounding the lesion, frequently cannot create more than suspicion of its true character.

Not only is the accurate diagnosis of intragastric lesions often difficult, but clinicians and pathologists have never been able to agree upon whether a benign gastric ulcer ever becomes malignant. We are cognizant of the arguments which have been advanced against the thesis that a benign gastric ulcer may provide the background for a subsequent malignant growth. Every clinician of experience must have observed instances of malignancy affecting a portion of the stomach where for months, or even years, there was present by roentgen study a lesion which was considered to be a benign gastric ulceration by every diagnostic aid. The ulcer healed and then recurred and again, until finally at operation a malignant lesion was demonstrated with metastasis to other areas—a tragic admission of the frequent failure of diagnostic methods prior to biopsy. It may well have been malignant from the beginning, but it may well not have been.

We have very carefully restudied 156 consecutive case histories in which gastric resection was performed for gastric ulcer and, in addition, we have selected from a larger group, 37 case histories in which gastric resection was performed for a small gastric ulceration and in which the final diagnosis was gastric carcinoma. The 37 selected cases were instances of relatively small ulcerated lesions presenting difficult problems in differential diagnosis between ulcer and cancer.

In this series of 193 cases of cancer and ulcer, an analysis of the clinical data regarding the age of the patient, the duration of symptoms, the degree to which symptomatology was considered to approximate the typical ulcer history, gastric acidity and the size of the ulcer, yielded results quite in accord with the experience of others, namely, that there are distinct differences between series of cases of ulcer and of cancer, but that exceptions are too numerous to permit use of these differences in the differential diagnosis of the individual patient. Our data regarding location of the ulcer are of interest, suggesting that approximately one-fifth of gastric ulcers are malignant no matter where they occur—on the greater or lesser curvature, close to the pylorus, or at a distance from it or near the cardia (Table 1).

The great majority (77 per cent) of all gastric ulcerations, benign or malignant, occurred on or involved the lesser curvature of the stomach. It is noteworthy that eight benign gastric ulcers were observed on or involving primarily the greater curvature of the stomach.

It is of interest to examine our diagnostic errors in these patients. Of 44 instances in which the preoperative diagnosis was carcinoma or probable carcinoma, the diagnosis following histologic study of the lesion was established as cancer in only 19 (43 per cent), as shown in Table II. Twenty-five (more than 50 per cent) of these patients had a benign gastric ulcer.

Ninety-nine patients were operated upon with the presumptive preoperative diagnosis of gastric ulcer. Eleven patients (11 per cent) in this group were subsequently proven to have carcinoma of the stomach.

In 38 of the patients' histories selected for inclusion in this study, the presumptive preoperative diagnosis was duodenal ulcer. Thirteen of these patients were known to have had a duodenal lesion and possibly others did also, but restudy of the clinical records and the pathologic material does not provide conclusive evidence on this point. In 35, an ulcer was demonstrated to be present in the stomach at operation. In some of these patients accurate clinical diagnosis was virtually impossible because
of a high degree of pyloric obstruction, and in a few it was not attempted because severe hemorrhage created an emergency situation. A few of these misdiagnosed patients had small ulcers which were immediately adjacent to the pylorus. There remained, however, at least nine patients in which roentgenologic examination was considered satisfactory, yet in which the ulcer was well away from the pylorus.

Table I.—Incidence of Carcinoma in Gastric Ulcer According to Location.

<table>
<thead>
<tr>
<th>Location</th>
<th>Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesser Curvature</td>
<td>16%</td>
</tr>
<tr>
<td>Anterior Wall</td>
<td>0%</td>
</tr>
<tr>
<td>Posterior Wall</td>
<td>19%</td>
</tr>
<tr>
<td>Greater Curvature</td>
<td>19%</td>
</tr>
<tr>
<td>Circumferential</td>
<td>39%</td>
</tr>
<tr>
<td>Prepyloric Region</td>
<td>15%</td>
</tr>
<tr>
<td>Mid-Portion</td>
<td>18%</td>
</tr>
<tr>
<td>Fundus</td>
<td>19%</td>
</tr>
<tr>
<td>Cardia</td>
<td>33%</td>
</tr>
<tr>
<td>Total</td>
<td>19%</td>
</tr>
</tbody>
</table>

Of far greater significance is the fact that three cancer patients included in our series were operated upon with a preoperative diagnosis of duodenal ulcer. One of these patients, a 76-year-old male, had had ulcer symptoms for 30 years, finally coming to surgery because of partial obstruction. The roentgen study showed gastric retention and duodenal scarring. The patient had a small invading pre-pyloric cancer distinct from the duodenal ulcer.

The second of these three patients was a 37-year-old male with a two-year history of ulcer. He was repeatedly studied roentgenologically while under medical therapy and was finally referred for operation because of supposed intractability of an ulcer. His lesion proved to be a pre-pyloric ulcerated cancer.

The third patient is the most significant one of this small group. The patient was a 46-year-old male with a nine-month history. On roentgenologic study he was thought to have a duodenal ulcer with antral gastritis. He failed to improve on medical therapy and after several months was subjected to subtotal gastric resection. Histologic examination revealed a lesion which closely simulates the circumferential, linear, benign gastric pyloric ulcer. A defect in the muscle is filled in with scar tissue. Duodenal mucous membrane is present at one margin of the small ulcer, gastric mucosa on the other. However, the scar tissue is diffusely infiltrated with malignant cells.

Of the 37 gastric cancer patients selected for this study, only 19 were operated upon either because their lesions were diagnosed as cancer or because cancer was seriously considered. Of the 18 remaining patients, the preoperative diagnosis was that of benign gastric ulcer in 11 patients, while in three instances the diagnosis of a duodenal ulcer, and in one the diagnosis of marginal ulcer had been made. In more than one-third of the patients the diagnosis of benign gastric or duodenal ulcer had been incorrectly made prior to resection after careful study.

We believe we have fairly presented the accuracy of preoperative diagnosis in differentiating between benign and malignant gastric ulcers. At operation the surgeon did not consistently come to the correct diagnosis. Although the operating surgeon recognized four of the clinically unsuspected cancers for what they were, this was more or less offset by the fact that also at operation the surgeon suspected malignancy in eight of the benign ulcers which were correctly diagnosed preoperatively. We are sure that our experience is not a unique one.

The pathologist also makes mistakes. He was correct in all but one of the misdiagnosed cancers upon gross examination of the stomach subsequent to resection, but there were seven carcinomas properly diagnosed preoperatively that the pathologist failed to recognize grossly.

Most of the more recent material included in this series has been studied by gross serial section, and the reconstruction of some of these lesions has yielded interesting
information. Fifteen of the lesions in this series were deeply penetrating ulcers characteristic of the benign gastric ulcer, in that the base consisted of scar tissue outside of the muscle coat. In ten of these, cancer cells were demonstrable throughout the base and in the wall of the ulcer on all sides. We admit that this should not be accepted as morphologic evidence of the origin of carcinoma in a pre-existing benign ulcer, in spite of the fact that the lesions occurred in patients who had complained of ulcer symptoms for from six months to three and one-half years.

Five of the lesions in this series, however, presented not only the characteristic gross and histologic features of a primary gastric ulcer, but had cancer cells arising in only one part of the ulcer wall. The duration of symptoms of these five patients varied up to five years. We regard these lesions as clear-cut evidences of gastric cancer occurring in an area of primary benign gastric ulceration. They cannot be regarded otherwise. The development of such a lesion is admittedly uncommon, only five (2.7 per cent) of 186 consecutive resections for gastric cancer in which we are reasonably confident of this sequence of events. If the ten cases in this series where the patients had deeply penetrating ulcers characteristic of the benign gastric ulcer, but in which cancer was demonstrable throughout the base and in the wall on all sides were included, there would be 15 patients with an incidence of 8.1 per cent. Attention should be called to the fact that the true incidence may be greater than 2.7 per cent.

A great deal of the reasoning advanced against the development of cancer in a pre-existing benign gastric ulcer denies the fact that cancer prophylaxis is, in part, based upon the recommendation of excision of chronic ulcers before malignancy can be demonstrated. We believe that we are at the point where we need less argument about this matter and closer observation of our patients and study of their material.

Of the 37 patients in this series with cancer, there was significant delay between the time of seeking medical advice and gastric resection in 19. In two instances this was due solely to the patient. In the remaining 17 patients it was due to medical advice, the patients being treated medically for the periods indicated in Table III. When these 17 patients finally did come to operation, the true diagnosis had been made in only one of them. It is, of course, not known that all of these patients actually had malignant disease when medical treatment was begun. A brief report of one of these patients will suffice to illustrate the pitfalls of medical therapy.

The patient was a 55-year-old woman who had mild dyspeptic symptoms of five years' duration. Roentgenologic examination of the stomach was originally reported to show a benign ulcer. The symptoms subsided on medical therapy and eight months later the stomach was regarded as normal on roentgen examination. During the next eight months the exact symptoms returned.

### Table II.—Comparison of Preoperative and Final Diagnoses.

<table>
<thead>
<tr>
<th>Preoperative Diagnosis</th>
<th>Final Diagnosis</th>
<th>Ca</th>
<th>Ulcer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probable Carcinoma...........</td>
<td>44</td>
<td>19</td>
<td>25</td>
</tr>
<tr>
<td>Gastric Ulcer................</td>
<td>99</td>
<td>11</td>
<td>88</td>
</tr>
<tr>
<td>Duodenal Ulcer..............</td>
<td>38</td>
<td>3</td>
<td>35</td>
</tr>
</tbody>
</table>

### Table III.—Duration of Medical Treatment of Patients With Gastric Cancer.

<table>
<thead>
<tr>
<th>Time (Months)</th>
<th>No. Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-6</td>
<td>5</td>
</tr>
<tr>
<td>7-12</td>
<td>2</td>
</tr>
<tr>
<td>13-18</td>
<td>2</td>
</tr>
<tr>
<td>24-36</td>
<td>5</td>
</tr>
<tr>
<td>36+</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total.......</strong></td>
<td><strong>17</strong></td>
</tr>
</tbody>
</table>
and a definite lesion was detected on gastrointestinal roentgenologic examination. The patient had twice been gastroscoped by distinguished clinicians and the diagnosis of benign gastric ulceration had been made. Resection, performed five years after the symptoms first appeared and 16 months after the demonstration of gastric ulceration, which repeatedly was reported as healed and breaking down, proved the lesion to be an ulcerated carcinoma with metastasis to lymph nodes along the lesser curvature. Had she been operated on when the diagnosis of gastric ulceration was first made, at least 16 months would have been saved, a time at which metastasis to regional lymph nodes might not have taken place.

DISCUSSION

It is to be hoped that repeated reminders of our present diagnostic fallibility will increase the number of patients being referred for surgery when the diagnosis is originally made of a gastric ulcer. Here and there in a few places, internists and gastro-enterologists have accepted the fact that accurate diagnosis is not always possible, in fact it is often impossible, and they are therefore referring these patients immediately for gastric resection.

We must admit the possibility that up to 10 per cent of benign gastric ulcer patients may eventually develop gastric cancer at the site of the benign ulcer. Because of this and because of the record of admitted diagnostic errors at every institution, and because the three to six, or even eight, weeks' trial of medical therapy so frequently stretches into months or even years, we believe that the therapy of gastric ulcer should be regarded primarily as a problem for the surgeon, provided the surgeon is sufficiently able and experienced in gastric surgery to perform radical gastric resection with a satisfactorily small operative risk. We agree with Grimes and Bell that, because of the number of errors that are made in preoperative diagnosis and further contributed to by the surgeon at operation, and even by the pathologist on gross examination, the operation performed should, as a rule, be the same with respect to the omentum as the procedure that would be followed for a known cancer.

After a substantial experience with total gastrectomy for gastric cancer, we are convinced that this operation is not the desired answer to gastric cancer. The answer to gastric cancer lies in the earliest possible removal of neoplasms of the stomach which may become cancer, in the radical excision of all gastric ulcerations when they are diagnosed, and, when these objectives have not taken place, in the radical excision of gastric cancer before metastasis has occurred. We should become more cognizant of the more satisfactory survival rates when the cancer is still limited to a small portion of the stomach and when demonstrable lymph node metastasis has not taken place. Only by continually pointing out these facts can we offset the statement that the prognosis of gastric cancer is so bad that the few weeks' or even months' delay occasioned by trial of medical therapy really makes no difference in the ultimate outcome. This is hardly consistent with the aggressive attitude toward cancer which all of us are working so hard to foster.

BIBLIOGRAPHY


DISCUSSION.—Dr. FRANK H. LAHEY, Boston, Mass.: I do not want to talk about the surgeons, I want to talk particularly about the gastro-enterologists because they are the ones who need persuasion. If we could get them to approach this problem from the viewpoint of both these papers,
I am quite sure we could accomplish a good deal. We have done so successfully in adenomas of the thyroid and malignancy but we still cannot with gastric cancers. This problem is still approached psychologically by gastro-enterologists from the point of view that there is such a thing as malignant degeneration of a gastric ulcer. If we could persuade them to accept the other viewpoint that practically never are there degenerations on ulcers, that they are carcinomas from the beginning, they would be a little more timid about continuing with prolonged medical management. I have preached the theory that it would be best to operate on every patient with gastric ulcer, but it does not work. Two prominent members of this association who really know about this lesion, to my knowledge have had gastric ulcers and neither has had surgery. One of my medical friends is now in our hospital with a gastric ulcer that has now reopened for the second time, and he refuses surgery. It is a fine theory, but in practice it has its difficulties. It is easy to preach it if you do not have to do it.

I do think that we could really improve this situation if we could get the gastro-enterologists to compromise, and ours have. If they would only realize that they do all the things to a patient which conceal the recurrence of his ulcer or extension of his malignancy. They change his habits, they change his diet, they neutralize the stomach contents, they give him antispasmodics, they make him stop smoking, they make him stop drinking, and when he really gets symptoms of malignancy which force him back to the gastro-enterologist, and so to the surgeon, it is often too late.

What we have tried to do with our gastro-enterologists is this: We have asked them to see every patient with a lesion of this sort which they have let go too long, and to have a conference with the surgeons on every patient with a gastric ulcer before proceeding with medical treatment. We ask them to look at the lesion, and we have said to them that what they should do is to talk to the family and tell them why this patient is ultimately going to die of his cancer, and not ask us to try to explain it for them. What we would like them to do if they treat gastric ulcers medically—and they are quite agreeable to it—is to have every patient with gastric ulcer roentgen rayed again in a month. If it is negative, we let the patient go two months; if it is still negative we let him go three months; and if it is still negative he can go six months before the next examination. That is not perfect but it is a reasonable compromise, to agree that every one which fails to close, or reopens, should be operated upon; that every individual who has a gastric ulcer under medical treatment should be told frankly that he has about a 15 per cent chance of having a cancer that may become inoperable if he goes on with it. That is a harsh position but, on the other hand, it is a reasonable approach. We can ask the gastro-enterologists to compromise thus with us so that we can do the things we would really like to do—that is, to try to avoid as much as possible the unnecessary loss of life from cancer of the stomach which goes with not resecting the stomach in all patients who have what appears to be a gastric ulcer. If they will compromise thus, I am sure we will save more patients with carcinoma of the stomach than we now do.

DR. HUGH H. THROUT, JR., Roanoke, Va.: I arise to emphasize one point that Dr. Marshall, Dr. Ravdin and Dr. Lahey have all made, as coming from a surgeon connected with a small group.

Our internists some years ago had the idea of watching gastric ulcers for a fairly long time, as a result of which several cases were seen in which malignancy progressed further than it should have done. When this occurred I decided to see if there was some way I could get them to come to the surgeon's hands sooner. In 150 successive operations for gastric ulcer, at operation I made a diagnosis which I told the pathologist was my gross diagnosis. I found that in between 10 and 15 per cent of the cases I was in error in my diagnosis with the lesion in my hand. Those statistics I have repeatedly given to my internist friends and I am delighted to report that now in nearly every case of gastric ulcer, the surgeon is called in immediate consultation. I believe if we keep talking on this subject to our medical friends we will obtain these lesions sooner.

DR. SAMUEL F. MARSHALL, Boston, Mass. (closing): I want to thank Dr. Lahey and Dr. Trout for discussing this very important problem. Dr. Waltman Walters pointed out just a short time ago that any individual past the age of 40 with recurrent gastric ulcer should be operated upon immediately, and with this we agree and perhaps go a step further. We would even operate on those less than 40 years of age. We have had a young woman age 19 with recurrent gastric ulcer which at operation proved to be malignant; she had had symptoms for two years.

As I talked to Dr. Ravdin the other night, I thought we were rather in disagreement, but it seems that perhaps our talk brought us closer together than I expected, and we are very much in agreement about this problem. I should like to point out that I firmly believe that every recurrent ulcer, every ulcer that does not heal, should be operated upon, and in that small percentage that
the gastro-enterologists do treat, we, together with our medical associates, insist upon having treatment in the hospital, and the decision (for or against surgery) should be made while the patients are still in the hospital. If the ulcer does not heal, or if it does not show progressive healing, we should operate upon that patient. If we allow them to leave the hospital and come back, or perhaps not come back, with recurrent symptoms, recurrent ulcer and recurrent treatment, such delay may be disastrous and should not be permitted.

Dr. I. S. Ravdin, Philadelphia, Pa. (closing): I am grateful to Dr. Lahey and Dr. Trout for their discussion. I have a deep and abiding faith in what Frank Lahey has to say. I am happy to say that at the Hospital of the University of Pennsylvania, patients with gastric ulcer are now sent to the surgeon, where they ought to be sent. It is the only way that we can improve the end results of gastric cancer. Every one of these sections I spoke about have been cut by serial section, and if you gentlemen will get your pathologists not to cut a single section, or two or three sections, but to cut serial sections through these ulcers, you will find these early cancers. They are there, and those are the patients whose lives we may later lose. We can improve the end results of gastric cancer without doing total gastrectomies or anything else except a radical resection in the early stages of gastric carcinoma. We are operating on every one of the gastric ulcers sent to us.
CONTACT SPLINTS (EGGERS) VS. STANDARD BONE PLATES IN THE FIXATION OF EXPERIMENTAL FRACTURES*

J. ALBERT KEY, M.D. AND FRED C. REYNOLDS, M.D.

ST. LOUIS, MISSOURI

FROM THE DEPARTMENT OF SURGERY, WASHINGTON UNIVERSITY SCHOOL OF MEDICINE, ST. LOUIS, MISSOURI

It is believed that the union of two bones or bone fragments will be more likely to occur and will occur in a shorter time if the surfaces which are expected to unite are not only placed in contact, but are actually pressed together. In 1932 one of us published a method in which positive pressure was used postoperatively in arthrodesis of the knee (Key'). While other procedures have been used from time to time, this method has remained the standard procedure in our clinic. This is because the bones seem to fuse more quickly and more surely when positive pressure is used.

We have used transverse pins through the femur and the tibia and these were pulled together by turnbuckles which were tightened from time to time. Charnley' has used the method with success and has devised a special clamp for pulling the pins together.

There seems to be no question but that by this method, union between two surfaces of cancellous bone will occur more rapidly than by any other method with which we are familiar. Recently Charnley' has shown by biopsy specimens that bony union can occur as early as four weeks after the operation and that it occurs with the production of a small amount of callus which is used to the best mechanical advantage and fixes together the trabeculae of the opposing surfaces.

Whether the pressure or the more perfect apposition and immobilization resulting from the pressure are the important factors in promoting union is a question to which we as yet have no satisfactory answer. In an attempt to answer this question Eggers, Shindler, and Pomerat® cut three-sided flaps in the parietal bones of rats and by means of rubber bands forced one side of the flap against the adjacent cut surface of the parietal bone. This side united to the parent bone with rapidity and consistency while union failed to occur on the opposite side which was separated from the parent bone by about 300 micra. Likewise, union failed to occur on either side of flaps which were not subjected to pressure, and were separated from the parent bone by the width of the saw cut (150 micra).

Eggers used the term contact compression factor to denote the conditions which are important in stimulating osteogenesis. He further stated that the optimal pressure is somewhere within the physiological limits of the force exerted by the musculature of the individual, because he noted aseptic necrosis of the bone and failure of union in areas where too much force was used and lack of pressure failed to stimulate osteogenesis.

Ford, Lottes and Key® believe that the parietal bone was a poor choice for the study of fracture healing because the control saw cuts did not unite by bone even after 94 days. Consequently, they per-

formed similar experiments using flaps cut in the ilium with inconclusive results. In another series of experiments they bored two holes in the outer table of each ilium of dogs and placed the ends of autogenous rib grafts in these holes. On one side a section of rib just long enough to span the distance between the holes was used and this lay loosely in the holes being maintained in position by the gluteal muscles which were sutured over it. On the other side a section of rib longer than the distance between the holes was used and this was sprung into position by bending the rib, thus considerable pressure was exerted by the ends of the rib upon the margins of the holes. On both sides the ends of the ribs became fused to the ilium by bone which grew out from the ilium, and the degree of union was about the same on both sides.

In specimens removed one week after operation, delicate trabeculae of new bone extended out from the ilium and were applied to the surface of the graft as appositional bone. In the three week specimens these trabeculae were more abundant and robust and in the gross specimens on both the pressure and the non-pressure sides the grafts were firmly united to the ilium by bone. Consequently, the authors believe that contact or apposition and immobilization of the fragments are more important than pressure in influencing union.

In discussing this paper, Abbott noted that the amount of pressure on the pressure side was inconstant because the authors stated that the ribs lost their elasticity, and Eggers remarked that the muscles which were sutured over the grafts exerted some pressure on the non-pressure side. Another objection was that the rib graft was not a living flap. All of these criticisms were well taken and it is admitted that the above was not a perfect experiment, but it did cast doubt upon the importance of pressure in promoting bone union providing contact and immobilization are maintained.

Whether or not the same principles are applicable to compact bone is still a moot question. Over 20 years ago one of us (Key) used the positive pressure method on a patient with congenital pseudarthrosis of the tibia, but union did not occur. He then tried it on experimental transverse fractures of the middle third of the shaft of the tibia in dogs; here too the results were inconclusive and were not published.

When a bone is broken the bone cells in the lacunae adjacent to the fractured surface die, probably from inanition caused by an interference with the circulation of fluid through the canaliculae in this area, and there is thus created a zone of devitalized bone on either side of the line of fracture. Because of this terminal devitalization of each fragment, Eggers believes that when a fracture of any nature is reduced, devitalized tissue is placed against devitalized tissue; and the removal of this must be accomplished in the physiology of the healing before solid bony union occurs. In other words, in fracture healing the inactive area of devitalized bone is gradually absorbed and this permits the viable bone of each fragment end to come into contact and to unite with its fellow. The continuous contact is accomplished by the longitudinal muscle thrust in closed reductions. In other words, as the devitalized ends of the fragments are absorbed, the pull of the muscles takes up the slack and maintains the contact.

In order to assure continuous contact of the ends of the fragments, Eggers devised a contact splint or slotted bone plate which will permit the fragments to slide together as their necrotic ends are absorbed. This is accomplished by the muscle tone of the extremity.

We have used the contact splint or slotted plate in a moderate number of fractures of long bone shafts in which internal fixation was indicated, but in our hands its use has not always been followed by prompt bony union.
union and we are not sure that it has any advantage over the standard bone plate. In order to determine its value two methods are feasible: (1) the use of contact splints and standard bone plates alternately by one surgeon in a sufficiently large series of fractures of long bones to warrant conclusions as to the relative efficiency of each method when the progress and end-results of the cases have been carefully studied and (2) the use of a contact splint on one side and a standard splint on the other in order to fix the fragments after identical fractures of long bones in experimental animals. We have chosen to study the relative value of the contact splint and the standard type of bone plate by the second method in experimental animals and shall report the results in this paper.

MATERIAL AND METHOD

Nineteen large adult dogs were operated upon under general anesthesia. The shaft of one femur was exposed and sectioned transversely with a Gigli saw. In the first ten dogs the fracture was reduced as accurately as possible and the fragments were fixed with a bone plate of the standard type, three inches long, with three screw holes in each end. The plates and screws were made of 18-8 SMO stainless steel. In four of these the plate bent slightly, and one or more screws became loose. Consequently, in the remaining nine dogs extra heavy plates of the same length were used; two of these bent and in four of them, one or more screws loosened. One end of the plate was fastened to the femur with three screws before the femur was cut with the saw. All screws were standard self-tapping, were inserted through a 7/64 inch hole and penetrated both cortices of the femur and were tightened firmly (Figs. 1 to 6). The wound was then closed. The opposite femur was exposed and a similar fracture was produced and the fragments reduced and fixed with an Eggers contact splint (slotted plate), 3 inches long and with three screws in each fragment. In applying this plate the screws were driven home, then those in both fragments were backed out one turn, thus loosening the plate and permitting the fragments to slide together on the plate. The fracture was then impacted by pressure on the knee and hip. The wound was closed and the animal was permitted normal use of the legs as soon as it recovered from the immediate effects of the operation. This they did with the exception of one unusually
large dog in which the screws pulled out of one fragment in each femur. This animal limped for a while but both fractures were firmly-united by bone with considerable deformity at 11 weeks. Four animals were sacrificed before the minimum time of 8 weeks after the operation. The remaining 15 animals were sacrificed at intervals of from 8 to 14 weeks.

The femora were removed and inspected for union and callus, and roentgen rays were taken in two planes. The plates were removed and the bones tested for union and fixed in 10 per cent formalin. They were decalcified and split, and the medullary canal was examined. Microscopic sections were then prepared and studied.

When the specimens were examined, granulation tissue, indicating mild infection, was found in four femora. In all of these the wounds were healed and no pus was present in any of them. In two instances the heavy standard plates bent slightly, but this did not interfere with union and in one instance, the screws pulled out of one fragment on both sides, but bony union with deformity was present 11 weeks after the operation. (These screws had been used once before; hence, we believe that for maximum efficiency, self-tapping screws should not be used a second time.) In no instance did the contact splint bend.

**Gross examination.** In the three animals sacrificed eight weeks after operation, solid bony union was not present in any instance, but in one case union on the side with the slotted plate was definitely more firm than on the side with the standard plate. In one of these animals mild infection was present on each side and the firmness of the union was about the same on each side.

In one of the nine week animals firm fibrous union was present on both sides, but this was more firm on the side of the slotted plate. In the other, mild infection and non-union were present on the slotted plate side while the fragments fixed with standard plate were firmly united by bone.

Of the three animals sacrificed ten weeks after the operation, in two both femora were united by bone, in the third, the slotted plate side was mildly infected and not united by bone, while the standard plate side was firmly united.

Of the three animals sacrificed at 11 weeks, in one the screws had pulled out of both femora and the fragments were united by bone, with shortening and angulation. In another, infection and fibrous union were present on the standard plate side and the slotted plate femur was united by bone.
In the third, fibrous union was present on both sides, but was a little more firm on the slotted plate side. A mild infection was present around the slotted plate in the 12 week animal and the hip on this side was septic. This animal was debilitated and bony union did not occur on either side. In the 13 and 14 week animals bony union was present on both sides and there was little difference between them.

Roentgenogram Findings. In the roentgenograms of the specimens, the findings agree fairly well with those noted on gross examination in that those specimens which were united by fibrous tissue showed lack of union in the roentgenogram, and usually those which seemed to be solid on gross examination showed bony union in the roentgenogram (Figs. 1 and 2). However, some fractures which were solid on gross examination did not show bony union in the roentgenogram, thus the roentgenogram findings lag a little behind those on gross examination (Fig. 6). In three instances where bony union was present on both sides, the union appeared to be slightly more advanced on the slotted plate side and in one instance it was more advanced on the standard plate side (Figs. 4 and 5). Where infection was present there was considerable subperiosteal new bone formation around both fragments. In some cases there was also absorption and sequestration, and in no case with infection were the fragments united by bone (Fig. 3).

Microscopic examination. In all specimens there was the usual collar of subperiosteal new bone and callus around the end of each fragment, and the medullary canal was likewise filled with newly formed cancellous bone. In the 8 to 11 week specimens, a massive external callus of connective tissue, cancellous bone and cartilage which was being calcified and then invaded and replaced by bone, occupied the area around the apposed ends of the fragments and filled the marrow canal. In the later specimens this external callus was smaller; the fibrous tissue and cartilage of the external callus had largely disappeared and the fractures were surrounded by a collar of cancellous bone. The same was true of the medullary canals. Only a narrow incomplete zone of cartilage and fibrous tissue extending across the medullary plug of cancellous bone indicated the site of the fracture.

In four instances (at 9 and 10 weeks) cyst-like cavities containing an amorphous precipitate (old blood) were present across the fracture site and the inert devitalized ends of the fragments projected into the cavity while union was effected by the
massive external callus (Figs. 9 and 10). In all specimens (8 to 14 weeks) destruction of the devitalized bone by osteoclasts and by vascular connective tissue was evident, but this was not an orderly erosion of the ends of the fragments such as would result in a shortening of the bone or in the creation of a gap between the bone ends. It was rather an irregular erosion of the sides and ends of the devitalized zone, and especially an extensive internal erosion with enlargement of the vascular canals in the compact bone, so that it was converted into a coarse cancellous structure which is being reorganized (Figs. 7 and 8). However, in some instances terminal erosion of the devitalized ends of the fragments was seen (Fig. 10). This appeared to be apt to occur where a hematoma or cystic cavity was present between bone ends, which were themselves covered by connective tissue or where infection was present. In such instances, the fragments might be firmly united by external callus unless infection prevented union, and no shortening resulted from the terminal erosion.

Along with this destruction, formation of new appositional bone was evident. This appeared to grow out from beneath the periosteum and arise from the cells of the endosteum and those lining the vascular canals, and tended to adhere to and envelop the devitalized ends of the fragments and thus protect them from erosion by connective tissue and osteoclasts (Fig. 7). Apparently as the bone cells in the lacunae die, not only are the osteoclasts and erosive connective tissue cells stimulated, but the osteogenic cells which cover the periosteal and endosteal surfaces of the cortex and line the canals in the compact bone begin to proliferate and form new bone. This new bone is formed directly from a fibrous connective tissue matrix which is calcified very soon after it is formed and may project out from the surface as delicate trabeculae, or spread over the surface as a thin layer of appositional bone. This appositional bone covers and adheres to living or devitalized bone indiscriminately and in some sections at eight weeks, is seen covering the devitalized end of the fragment.

The lamellae of this appositional bone covering the end of a fragment tend to lie parallel with the surface to which the bone is adherent, and thus are at a right angle to the lamellae of the devitalized bone, while those on the sides of this are parallel with those of the original bone (Fig. 8). From this basal layer trabeculae may project outward in various directions as though groping for other bone with which they can unite (Fig. 9).

If the trabeculae in reaching out contact similar trabeculae from the opposite fragment or even the devitalized end of the other fragment, they adhere to and tend to cover the surface of the newly encountered bone, be it living or dead, and thus primary union of fragments may be accomplished by appositional bone without passing through the stage of cartilagenous callus (Fig. 9).

Where the fragments are close together, not only are they covered by appositional bone, but this bone forms trabeculae which fuse with those springing from the opposite fragment and thus union is accomplished not only by the periosteal and medullary callus, but also by fusion of the fragments by appositional bone (Fig. 10). This condition is seen in several specimens. In the older ones (12 to 14 weeks) the bone fusing the two devitalized ends of the fragments is quite robust, with evidence of extensive internal erosion and reconstruction of this zone which lies adjacent to the living bone of the cortex. As the vascular canals are enlarged, new appositional bone covers their walls, and in some sections there are islets (really cross sections of trabeculae) of devitalized bone which are completely enveloped by living appositional bone.
CONTACT SPLINTS VS. STANDARD BONE PLATES

Fig. 7

Dog #17. Eleven weeks. A. (Low power.) Both ends of fragment with calcifying osteoid between. This and apposition bone seal the ends of the fragments and prevent terminal erosion. B. Outlined area magnified 100 times to show devitalized end of the fragment sealed by appositional bone and callus on the side and over the end.

Fig. 8

Dog #8. Ten weeks. A. Showing well approximated ends of the fragments fused by appositional bone (low power). B. Area magnified 100 times to show devitalized ends of both fragments. There is marked internal erosion but the ends of the fragments are sealed and united by the new bone.

Fig. 9

Dog #17. Eleven weeks. A. End of the fragment showing moderate terminal erosion with small cyst (low power). B. End of opposite cortex showing devitalized bone projecting into cystic cavity and not being eroded, but there is considerable internal erosion. The pulling apart of the connective tissue is an artefact but the cyst is not. This fracture firmly united by periosteal callus and new bone.

Fig. 10

Dog #11. Thirteen weeks. A. Slotted plate side (low power), showing mild infection and marked terminal erosion. Not united. B. Dog #3, 9 weeks, showing marked lateral erosion. On left part of cortex projects into cyst and appears inert. On the right of this there is moderate terminal erosion by connective tissue and osteoclasts.

The above occurred on both the standard plate and the contact splint sides and no constant differences were noted between the two. The distance separating the fragments seemed to be the important factor and in no instance were they microscopically in contact. But close approximation and firm immobilization favor direct union with a small amount of external callus (Fig. 8). Infection led to non-union, marked terminal, lateral and internal erosion and possible shortening (Fig. 10).

DISCUSSION

The findings of the gross, roentgenogram and microscopic examinations of the specimens coincided quite well, and there was a slight advantage in favor of the contact splint or slotted plate. It is believed that this is due to the fact that on this side the fragments were slightly closer together.
when consolidation of the callus occurred. This continued approximation of the ends of the fragments was due to the initial impaction and the continued weight bearing and pull of the muscles spanning the fracture.

With two exceptions, fractures which were not infected were united by bone in nine weeks or more. One exception was in a debilitated animal which had a mild infection, and a septic hip on the contact splint side was not united by bone in 13 weeks. The other was an animal in which only fibrous union was present at 11 weeks on each side. In this animal there was unusually wide separation of the ends of the fragments. This was not overcome by weight bearing and muscle tone on the slotted plate side.

It is believed that approximation and continuous immobilization of the bone ends rather than pressure per se is the important factor and that if the fragments are firmly impacted and so fixed with a standard plate, union will occur as surely and in approximately the same time as when the contact splint is used.

It is true that the devitalized ends of the fragments do not grow together and tend to be absorbed, but they may be fused by appositional bone and if union occurs, this absorption is usually accomplished by erosion from within and not by a gradual eating away of the ends of the fragments with telescoping of the extremity. In certain instances there is considerable terminal erosion of the devitalized ends of the fragments, but even here the major part of the absorption and replacement by living bone occurs after the fragments are united by cancellous bone of the medullary and periosteal callus, and we find no evidence that the shaft telescopes or shortens in any way, unless infection and/or nonunion occur.

However, if union fails to occur in the normal time, then the ends of the fragments are held apart by the standard plate as the devitalized bone is absorbed, whereas theoretically the contact splint, if properly applied, will permit the fragments to slide together and thus close the gap. Whether or not this will result in a higher percentage of union after delayed union occurs is outside the scope of these experiments. This also is true of the question as to whether or not the interposition of connective tissue between the fragments or adhesions around the plate and screws in these cases with delayed union will prevent the fragments from sliding together during the period when the fragments are being perceptibly shortened by absorption of the devitalized zones. We think that new connective tissue or bone may form around the plate and interfere with the sliding of the fragments on the plate even though the screws have been loosened. We have found clinically that if diastasis of a transverse fracture is permitted to persist even for a few days, it may not be possible to force the ends together and the separation may persist after all traction is removed.

These experiments indicate that the most rapid and most perfect fracture healing occurs when the fragments are fused by appositional bone and we should determine the conditions under which this is most apt to occur and strive to create them clinically. In the experiments of Ford, Lottes and Key, the grafts were fixed to the ilium by appositional bone in three weeks. It is believed that this is the manner in which impacted fractures in cancellous bone unite and that pressure per se is not a factor except in the sense that function tends to stimulate bone formation to meet physiological demands.

It is important that the fragments be approximately as closely as possible when the plate is being applied, and if a standard plate is used, so maintained until they are firmly fixed by the plate. If this is done there seems to be little choice between the standard plate and the contact splint, except that the latter is stronger, as we proved by actual test.
CONTACT SPLINTS VS. STANDARD BONE PLATES

BIBLIOGRAPHY


DISCUSSION.—Dr. ROBERT W. JOHNSON, Jr., Baltimore, Md.: I am always interested when Dr. Key speaks because he always has something to say that is worth listening to. He has given us a very workmanlike piece of research in this instance upon a subject that has been discussed at length from the point of view of the orthopedic surgeon. I have in the past carried out a good many experiments on the question of the circulation of blood in the bone and the collateral supply, the ability of the vessels to carry the load of repair about a fracture site, using the reparative effort as a gauge. In those experiments it was quite evident that we could expect little or nothing from the bone ends themselves, that repair, as Dr. Key showed, comes from more vascular areas in the neighborhood, the central canal producing a moderate amount of reparative action, the periosteum with its greater ability for hyperemia producing a vastly greater amount of repair. So that actually in the repair of a shaft fracture we are dependent upon the periosteum primarily to form that external weld, you might say, of the pipe that is broken. There is a small amount, an appreciable and valuable amount of bridging and repair that occurs from the point of view of the orthopedic surgeon, the central canal producing a moderate amount of reparative action, the periosteum with its greater ability for hyperemia producing a vastly greater amount of repair. So that actually in the repair of a shaft fracture we are dependent upon the periosteum primarily to form that external weld, you might say, of the pipe that is broken. There is a small amount, an appreciable and valuable amount of bridging and repair that occurs from the central canal, but in all instances the cortex, the cortical area, no matter how well it is apposed and brought together, does not enter into the function of union early. Cortical reconstruction has to be worked over in the months after injury rather than the weeks after injury. It is a reworking of the circumferential callus that gives the final reestablishment of the tubular shaft of the bone. I think we should put the stress in the healing of fractures of the hard shaft cortex on the circumferential periosteal callus, and should depend entirely on the external repair to carry that on. Our stress should be not so much on absolute apposition, absolute fixation, or compression, but on the maintenance of good physiologic activity of the periosteum, not only the actual periosteum but the entire soft tissue outside the bone; muscles particularly, and the fibrous tissue which carries the circulation. This does not, however, apply to repair of bone surfaces with big cancellous areas, as in arthrodesis of the knee or foot, where compression has been shown by Dr. Eggers of Galveston and Dr. John Charnley of Manchester, England, to be a factor.

Dr. Key's work, with that of Dr. Eggers and Dr. Charnley, has been interesting in producing evidence that the compression is a factor of primary importance in the healing of these cancellous bone ends, and not as a primary factor in the healing of shaft bone fractures.

Dr. J. ALBERT KEY, St. Louis, Mo. (closing): I wish to thank Dr. Johnson for his kind words. I agree with him that circulation is important. Insofar as we could, we did about the same amount of damage on each side.

The importance of this paper to me is that it shows we should get these bones as close together as we can, because the farther the bone ends are apart the harder it is for callus to reach out and make contact with the callus on the other end. I feel that immobilization should be as complete as possible, and while we do not advocate open reduction, we are doing it more than we used to. We have become bolder; we have sulfanilamide or penicillin or some other antibiotic available to use after we finish operating, and the boys just operate all over the place. They operate on things they would never have thought of doing before.

The point is, when operation is done, they should make a great effort to get the bones as close together as possible, and if they can make use of the appositional bone, it will make union quicker and surer. That is one point we have all missed in the past, and I think Dr. Johnson missed it just now—that is, we want to get to the place where we do not need external callus, we do not need the medullary plug; we want to seal them together. Dr. Carl Moyer and I talked the other day about this, and he wants to get a plastic material that can be painted over the ends of the bone to seal them together. Then it is all finished, and then you will get union in a few minutes.
CARDIAC ARREST DURING SURGERY
FRANK GLENN, M.D.
NEW YORK, N.Y.

FROM THE DEPARTMENT OF SURGERY OF THE NEW YORK HOSPITAL-CORNELL MEDICAL CENTER, NEW YORK, N.Y.

CARDIAC ARREST DURING a surgical procedure is a catastrophe. It is usually unexpected. Perhaps the greater amount of surgery done today and the extent of many procedures that more often require prolonged anesthesia account for the belief that cardiac arrest is on the increase. It has been pointed out with justice that in the past the condition was not always properly diagnosed or reported. Often it has been called status lymphaticus, cardiac failure, pleural shock, or death during surgery (or anesthesia), cause undetermined, to mention only a few terms. Thus, some contend that cardiac arrest seems more prevalent today because it is recognized more frequently and because hospital records are now better kept and more available for study.

At The New York Hospital, Cornell Medical Center, during the year 1952, 10,000 surgical operations were performed. Cardiac arrest occurred six times. Two other New York hospitals where comparable surgery is done reported five arrests in 10,000 operations and four in 6,000 respectively for the same period. Thus, in one surgical community cardiac arrest was recognized once in every 2,000 operations. If ten million operations are performed in the operating rooms throughout the United States in a year, as has been estimated by the United States Public Health Service, then a reasonable estimate of the incidence of cardiac arrest during surgery would be 5,000. How near this figure approaches the truth cannot be determined, but surgeons must consider it a major hazard. Repeated and continuous evaluation of the circumstances under which it occurs is necessary so that ways and means may be developed to prevent it and improve our methods of its management.

At the present time, there is general agreement that cardiac arrest is associated with decreased oxygenation of the myocardium through the coronary circulation and with vagal stimulation. Numerous factors such as inadequate supply of oxygen to the blood in the pulmonary circulation, a diminished flow of blood through the lungs because of pre-existing anemia, hemorrhage, shock, or occlusion of vessels may contribute to this situation. A sudden fall in blood pressure within the heart to a point where the flow through the coronary circulation is impaired will produce the same situation. If, for example, after resecting a coarctation of the aorta and completing the anastomosis, the clamp on the aorta is released too quickly, it will cause too rapid a drop in blood pressure and arrest may occur. The coronary circulation may be directly affected as well by direct procedures on and within the heart. During a mitral valvulotomy direct pressure may occlude the left coronary and cause arrest.

Then there is the much discussed vagal stimulation that can lead to cardiac arrest. Here the mechanism is poorly understood.
Although experimental work done long ago demonstrated that the heart can be slowed readily by stimulating the vagus, cardiac arrest is very difficult to produce in a well oxygenated animal. However, man may not have the same escape mechanism as the animal. Many authors, therefore, consider it rare for vagal stimulation alone to result in cardiac arrest. On the other hand, it has been demonstrated repeatedly by experiment that a diminished supply of oxygen to the myocardium renders the cardiac muscle much more responsive to the depressing action of the vagus. In general it may be said with considerable certainty that whenever the oxygen requirements of the myocardium are not met, it becomes particularly susceptible to the processes leading to slower and more irregular contractions and even to complete standstill.

Because anesthesia is so intimately associated with the exchange of oxygen in the blood, every facet of its administration requires consideration to attack this problem. Since many drugs which are used in preanesthesia preparation may depress respiration and in other ways impair the efficiency with which oxygen is supplied to the tissues, it is of the utmost importance that they be used sparingly and with caution and intelligence. The same concept applies to the anesthetic agent and its administration. It, too, should be used in just sufficient quantity to produce the desired anesthetized state. Overdose may lead to lack of oxygen and carbon dioxide accumulation. The most frequent cause of hypoxia is a poor airway. An adequate airway is one that provides a free and uninhibited passage for inspiration and expiration. No deviation from this fundamental need can be tolerated at any time. Obstruction to the respiratory tract must be guarded against always. To accomplish this, important preventive measures are employed routinely. For example, the stomach is emptied before anesthesia is begun, suction aspiration is used constantly during tonsillectomy, and an endotracheal tube is used in open operations on the chest. Three essential items of equipment should always be at hand before an anesthesia is begun so that, should obstruction or impairment of the airway occur, it may be corrected promptly. These items are a laryngoscope, an endotracheal tube, and equipment to perform artificial ventilation.

Although the respiratory and circulatory systems may be considered separately, it should be pointed out that they require common evaluation in operations within the chest, where sudden changes can take place when the pleura is opened. A shift in the position of structures caused by a mediastinal or intracardiac tumor may result in changes in the respiratory tract or in the coronary circulation, or in both, as well as possible vagal stimulation.

In a panel discussion on cardiac arrest conducted by Gibbon at the 1952 Clinical Congress of the American College of Surgeons in New York, it was evident that many surgeons and anesthetists were concerned about the diagnosis of cardiac arrest. They were fearful of subjecting a patient to cardiac massage unnecessarily. Apprehension was apparent that such a procedure done quickly and without regard to infection might be disastrous. The reply to their first question is that both surgeons and anesthetists are agreed that absence of a carotid pulse alone is justification for a diagnosis of cardiac arrest. Listening for heart sounds with a stethoscope, repeated attempts to obtain blood pressure readings and electrocardiogram recordings require precious time and may render successful resuscitation impossible. In answer to their second question, it was stressed that immediate cardiac massage is mandatory; that the establishment of an airway and artificial ventilation should be accomplished simultaneously and that the
risk of infection, comparatively speaking, is insignificant.

When a diagnosis of cardiac arrest has been made, two objectives should be sought at once. The first is to establish an adequate airway and the second is to re-establish cardiac action. If the patient has an endotracheal tube, controlled ventilation with 100 per cent oxygen should achieve the desired result. If an endotracheal tube is not in place, artificial ventilation should be instituted by means of a mask and bag, or by mouth-to-mouth insufflation, as precious time may be lost in attempting to intubate at this time. If ventilation is not adequate by these means, then the patient should be intubated. In the majority of cases this should all require less than 30 seconds to accomplish if the anesthetist has the proper equipment always at hand.

While the airway and controlled respirations are being established, the chest should be opened through the left fourth or fifth interspace without regard to asepsis or control of bleeding. A scalpel is the only instrument needed. With the chest open, the constricting effect of the ribs on the surgeon's wrist can be prevented with a wedge. Cardiac massage should be instituted immediately to produce palpable peripheral pulsations at the rate of 60 to 70 a minute. Meanwhile, aid and consultation may be sought. If adequate oxygen is delivered to the entire respiratory tree and effective cardiac massage is maintained, the viability of the brain cells can be preserved. At the same time the coronary circulation will benefit from the oxygen it receives.

Under these circumstances, possibly 90 per cent of cardiac standstills will improve. Should the heart not respond, a quarter cc. of 1-1,000 adrenalin introduced into the cardiac chambers is advocated by some. Two cc. of 2 per cent procaine may also be found helpful. In cases where ventricular fibrillation does not respond to cardiac massage, an electric current of 110 volts run through a defibrillator for two seconds may restore normal cardiac contractions.

Cardiac resuscitation may take place within a few minutes or it may be delayed for many minutes. Once regular cardiac contractions are re-established, the heart is quite likely to continue satisfactorily. If, however, the brain is deprived of its oxygen supply for from three to five minutes, irreparable brain damage appears to result. The length of time the brain can tolerate hypoxia is extremely short. For this reason, many articles on this subject have stated correctly that restoration of the blood flow by cardiac massage so as to make oxygen available to the brain is the most important and urgent step in the management of cardiac arrest. The decerebrate individual is a failure, for recovery from this state rarely occurs. Therefore, nothing should be allowed to interfere with re-establishing the much needed oxygen supply, whereas restoration of cardiac action may be delayed for a longer period.

Paralleling the increase in intrathoracic surgery, cardiac arrest has occurred more frequently during these procedures, particularly those in and about the heart. Although the likelihood of arrest is greater with this group of patients, it is also true that resuscitation can be accomplished more readily in such situations. The reasons are obvious. First, an endotracheal tube is customarily in place and already connected to an oxygen supply. In most cases the patient is being maintained with assisted respiration by the anesthetist. The surgeon becomes aware of arrest almost before the anesthetist, and, except in instances where he is working within the heart itself, he can begin cardiac massage instantly. If the head of the table is lowered slightly and an adequate supply of oxygen is being propelled into the lungs, the circulation of oxygenated blood to the brain can be readily maintained. Under such optimum circumstances cardiac action is usually re-estab-
lished within a few minutes. If it is not, there is still time for a decision to use drugs or a defibrillator if indicated. The most important point is that brain damage has been prevented.

Not long ago, during a mitral valvuloplasty, a tear occurred in the base of a narrow auricular appendage. To repair the tear with two sutures, it was necessary to retract the left coronary artery. The distortion of this vessel and the pressure on it produced cardiac arrest. Massage was begun immediately, 60 to 70 per minute. Five minutes elapsed before cardiac action was re-established. The patient's recovery was complete, however, and without sequela, namely, evidence of cortical damage. This situation merits comment because, until the cardiac arrest, the patient had a good supply of oxygen to the systemic circulation through assisted respirations with good oxygen exchange through an endotracheal tube. It is logical to assume that the reduced flow of blood through the left coronary was the cause of the arrest. Cardiac massage under these circumstances provided the brain with the oxygen it needed to maintain its viability until the heart resumed activity. This is the first objective in cardiac arrest and can be achieved if there is oxygen in the lungs that can be carried to the brain by cardiac massage.

Many instances of cardiac arrest can be prevented if the factors leading to it are well understood and steps are taken promptly to control them. This is the responsibility of both the surgeons and the anesthetists. Cardiac arrest is one of the major hazards of surgery today and must be anticipated. Only an awareness of its likelihood and an anticipation of it will insure its immediate recognition in other than intrathoracic procedures where the heart is under direct observation. A plan of action that can be followed immediately in the event of arrest is imperative if the rate of successful resuscitations is to be increased. All professional personnel directly involved in surgical procedures should be familiar with a plan of action or cardiac arrest routine and be ready to assume their role without hesitation. It is essential that the plan be simple and that it require a minimum of equipment.

At The New York Hospital, Cornell Medical Center, such a plan is being followed to anticipate cardiac arrest. No anesthesia is begun without the following equipment at the head of the table: a laryngoscope, an endotracheal tube, and equipment for artificial ventilation. In each operating room and in the postoperative recovery room there is a cardiac arrest tray and a simple instruction sheet. On the tray is a sterile scalpel and a triangular metal wedge. The instruction sheet reads as follows:

A. Respiratory
1. Establish an airway.
2. Connect airway with oxygen supply.
3. Practice artificial ventilation.
4. Lower head of table.

B. Cardiac
1. Enter left chest through an incision extending from the sternal margin to the mid-axillary line.
2. Insert metal wedge between ribs.
3. Massage the heart to produce a palpable peripheral pulse at the rate of 60 to 70 per minute.

C. These instructions are to be carried out by the physicians present, be they interns, residents or attendings.

A number of excellent articles on cardiac arrest have been published by both surgeons and anesthesiologists in the last few years. The group includes Beck, Lahey and Ruzicka, Johnson and Kirby, Dale, Reid, Stephenson and Hinton, Gibbon, Hinchey and Straehley, to mention only a few. They have stimulated interest in the subject so that now most hospitals are directing some effort towards its prevention and better management. A country-wide survey and
overall study of the problem seem indicated. These might be accomplished through the establishment of a "cardiac arrest registry." All hospitals would be invited to report their cases of arrest as they occurred. The data accumulated would be reviewed at regular intervals by a group particularly interested in cardiac arrest. Perhaps a summary of the material studied would be published annually, together with recommendations or suggestions aimed at prevention and better resuscitation.

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atomic weight
in milliequiv.

## REPLACEMENT OF ELECTROLYTES, AND CORRECTION OF ACIDOSIS AND ALKALOSIS

*twice as many calories as 5% dextrose, in equal infusion time, with no increase in fluid volume + a greater protein-sparing action as compared to dextrose + maintenance of hepatic function

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with Nupercainal

potent .... nonirritating .... nonnarcotic

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