intervals throughout the day; the patient is also encouraged by firm pressure on the chest. If pain is too severe a preliminary injection of pethidine, 100 mg., is given.

Should there be any evidence of circulatory failure a rapid transfusion of intravenous saline is given, with, if necessary, plasma. Apart from cases with associated haemorrhage, it has rarely been necessary to transfuse with blood.

At operation, simple suture has been undertaken and usually omentum is brought over the ulcer. Particular care is taken to swab above the liver for residual fluid.

Post-operative pain is alleviated by morphine 1/6 gr. (11 mg.) at night, and pethidine, 100 mg., intramuscularly by day, for the first two or three days. An enema is given on the third morning. The patient is allowed up on the fourth day and the sutures are removed on the tenth day. If any evidence of venous thrombosis is discovered anticoagulant therapy as described by Ball and Hughes (1949) is started.

Summary

An analysis is presented of 490 cases of acute perforation treated from 1938 to 1948, inclusive.

The total mortality and the operative mortality have fallen considerably.

During the first three years the operative mortality was 27%; during the last two years it was only 4%. It was thought that this improvement is mainly due to better anaesthesia and to the routine use of antibiotics.

A summary of routine management of cases is presented.

We wish to express our thanks to the surgeons who have allowed us to treat these cases post-operatively: Mr. T. G. I. James, Mr. J. D. Fergusson, Mr. N. M. Matheson, Mr. J. Bonnin, and Mr. C. Chapple. We are also most grateful to the anaesthetists, Dr. Rankin, Dr. Davenport Jones, Miss McClelland, and Miss Ransom, and to the ward sisters who have given us such great assistance; we should like to mention particularly Sister Edmunds and Sister Johnstone. We wish to thank Mr. Duncan, of Hillingdon Hospital, who kindly supplied the figures from his hospital, and to Mr. J. Wilson for help in tracing the earlier cases.

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A study of the arrangements for the care of children under school age is being made by Miss Gladys Pendred, Federal Officer of the Australian Association for Pre-school Child Development, during a two months' visit to the United Kingdom under the auspices of the British Council. Her programme includes visits to nursery schools, organizations dealing with research and guidance, teachers' training colleges, and central and local government departments. She arrived in Britain on January 7 and spent the first three weeks in London. Later she will probably visit Scotland for two weeks and Durham for a few days. Trained as a teacher, Miss Pendred became Director of Free Kindergartens in Melbourne in 1925, was Principal of the Kindergarten Training College, Perth, from 1928 to 1937, and Supervisor of the Kindergarten Union of Western Australia from 1940 to 1941.

PERFORATED CARCINOMA OF THE STOMACH SIMULATING PERFORATED GASTRIC ULCER

BY

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Occasional instances of perforation complicating carcinoma of the stomach have been reported for many years, but only recently has the condition been recognized to be common. Aird (1935) could find only 71 cases in the literature, to which he added seven cases from the records of the Edinburgh Royal Infirmary and one personal case. Since then several large series have been reported, including 36 by Boyce (1946), 44 by Bocharov (1944), and 133 by McNealy and Hedin (1938).

According to Bisgard and Overmiller (1944), perforation occurs in from 3 to 6% of all cases of gastric carcinoma admitted to hospital, the average incidence being 4%. In about half the cases the signs and symptoms are obscure and many have not been recognized until after death. The other half clinically resemble perforated peptic ulcers and are of particular interest, as they are often early cases and eminently suitable for radical surgery.

At the Central Middlesex Hospital, in the eleven years 1938-48, there have been 17 instances of perforated carcinoma of the stomach. Perforations were found at operation 11 times, but only three were recognized to be carcinomatous. A fourth was diagnosed as carcinoma by gastroscopy shortly afterwards, but seven were discharged from hospital with the diagnosis of simple gastric ulcer. Contrary to belief, perforation in a carcinoma does not result in the early development of peritoneal secondaries, and failure to make the diagnosis must be considered particularly unfortunate, as it is likely to occur when the lesion is local and when resection may offer a reasonable prognosis. The object of this paper is to draw attention to the frequency with which perforation occurs in carcinoma of the stomach and to suggest how the risk of misdiagnosis may be reduced.

Brief details of the 17 cases are shown in Table I. Fuller histories of the misdiagnosed cases are appended.

In some of the first seven cases it can be argued that the lesion was a simple ulcer at the time of perforation and that carcinoma developed subsequently in the ulcer or independently elsewhere in the stomach. The latter would seem unlikely because of the close relation between the site of the perforation and of the carcinoma when diagnosed. The former is a possibility in Cases 4, 5, and 6, in which the intervals between perforation and definite evidence of a neoplasm were 26, 30, and 22 months respectively, but in the others the intervals were short, being in each case less than one year. Two and a half years, however, is not a long history for carcinoma of the stomach, and it is more reasonable to believe that the perforation was related to the carcinoma in all.

During the same period, 1938-48, a total of 452 patients with perforation of the stomach and duodenum were operated on, 449* of which were thought to be benign

*The 455 perforations operated on, reported by Avery Jones, Parsons, and White (1950), included seven cases of jejunal ulcers and excluded Case 8 above, which was recognized to be carcinomatous before discharge from hospital.

TABLE I.—Cases of Perforated Carcinoma of Stomach

No.	Sex	Age	Findings at Operation for Perforation	Result
1	M	42	Perforated P.U. on anterior wall near greater curve 5 in. (12.7 cm.) from pylorus	Further operation 10 months later. Inoperable carcinoma anterior wall and greater curve; secondaries in liver
2	M	62	Perforated P.U. in antrum	P.M. 4 months later. Carcinoma of lesser curve and antrum
3	M	56	Perforated ulcer in antrum; ? P.U., ? carcinoma. Discharged hospital as P.U. (See case report)	P.M. 4 months later. Carcinoma, pyloric region of stomach; secondaries in peritoneum
4	M	49	Perforated P.U. on lesser curve 2 in. (5 cm.) above pylorus	Further operation 26 months later. Carcinoma of lesser curve; partial gastrectomy
5	M	34	Perforated P.U. high on anterior wall	Barium meal 30 months later. Neoplasm of cardia. Further operation 39 months after perforation. Carcinoma of cardia; partial gastrectomy
6	M	73	Perforated P.U. high on anterior wall near lesser curve	Barium meal 22 months later. Extensive neoplasm of fundus. P.M. 24 months after perforation; leather-bottle stomach
7	M	49	Perforated P.U. on middle of lesser curve	P.M. 5 months later. Carcinoma of pylorus extending up to middle of body
8	M	64	Perforated P.U. at pylorus	Further operation 4 months later. Inoperable carcinoma, pyloric region
9	F	75	Perforated carcinoma at fundus, inoperable	Died 3 days later. P.M. refused
10	F	72	Perforated carcinoma of pylorus, inoperable	Further operation 3 weeks later. Inoperable carcinoma of antrum. Died 5 years later
11	F	71	Perforated carcinoma near cardia, inoperable	Barium meal 3 weeks later. Extensive carcinoma of body
12	M	60	No operation, patient moribund	P.M.: perforated carcinoma of lesser curve, 2½ in. (6.35 cm.) from pylorus
13	F	34	Operation abandoned, patient too ill	P.M.: perforated carcinomatous ulcer of stomach (site not recorded)
14	M	75	No operation (known carcinoma of stomach)	P.M.: carcinoma of antrum. Perforated in 2 places
15	M	70	No operation (diagnosed perirenal abscess)	P.M.: carcinoma high on lesser curve, perforated into lesser sac
16	M	69	No operation (diagnosed ? ruptured bladder)	P.M.: perforated carcinoma of stomach (site not recorded)
17	M	42	No operation (diagnosed pulmonary tuberculosis)	P.M.: pulmonary tuberculosis; perforated carcinoma middle of lesser curve of stomach

at the time of operation. These have been analysed by sex, age, and site (Tables II and III) to determine whether the cases which were finally diagnosed as carcinoma had any special characteristics which might have helped to differentiate them from the benign ulcers.

As was to be expected, there were relatively fewer carcinomas in patients under the age of 40, and none were observed in those under 30. The total number of cases is, however, too small to make it certain that carcinoma can be excluded at any age.

The total number of female perforations is also too small for it to be concluded that the risk of carcinoma attached to perforation in women is different from that in men. On

TABLE II.—Sex and Age Distribution of Patients with Perforations of Stomach and Duodenum Considered Benign at Operation

Age	Male		Female	
	Final Diagnosis		Final Diagnosis	
	Benign	Malignant	Benign	Malignant
Under 30 ..	47	0	4	0
30— ..	88	1	6	0
40— ..	103	3	9	0
50— ..	94	1	6	0
60— ..	60	2	5	0
70+ ..	14	1	5	0
All ages ..	406	8	35	0

the other hand, the annual number of deaths from carcinoma of the stomach is practically the same in both sexes, so that carcinomatous perforations might be expected to occur with equal frequency in both sexes. The fact that all the perforations which were mistaken for simple ulcers occurred in men suggests that there is possibly some factor which makes men particularly liable to this complication.†

In Table III the male cases have been analysed by site. It is seen that all the duodenal perforations, as was to be

TABLE III.—Site Distribution of Males with Perforations of Stomach and Duodenum Considered Benign at Operation

Site	Final Diagnosis	
	Benign	Malignant
Duodenum	283	0
Pylorus	44	1
Stomach	79	7
Antrum		23
Lesser curve (middle) ..		30
Lesser curve (upper third) ..		14
Anterior wall		11
Greater curve		1
All sites	406	8

expected, proved to be benign. Ulcers described as pyloric or juxtapyloric at operation are, in modern practice, generally classified with duodenal ulcers, and barium meals subsequently showed their duodenal site in several of the patients. However, exact location at operation is difficult, and the possibility of pyloric ulcers being gastric must be remembered. One such case was certainly observed as one proved to be a carcinoma.

Subdividing the gastric ulcers according to site, it is seen that misdiagnoses were made in all parts of the stomach. It is generally recognized that ulcers on the greater curve and in the antrum are particularly likely to be malignant, and this series provides no exception, though it is too small for independent conclusions to be drawn. While, therefore, the general risk of an apparently simple perforated ulcer being malignant was low (8 in 449—i.e., 1.8%), it was appreciable in the limited group of male gastric ulcers (7 in 86—i.e., 8.1%). As no attempt was made to trace the patients who did not return to the hospital, the risk may have been even greater.

Histories of the Misdiagnosed Cases

Case 1.—A man aged 42 was admitted on September 8, 1941, with ten years' history of intermittent epigastric pain two and a half hours after meals, worse one week; severe pain for one day. At operation a large chronic ulcer was found on the anterior wall near the greater curve of the stomach 5 in. (12.7 cm.) from the pylorus, containing a perforation ¼ in. (0.3 cm.) in diameter; the perforation was sutured. A test meal on September 18 showed no free acid, and gastroscopy on the 26th revealed considerable puckering of the folds where the ulcer had been sutured, but no ulcer was visible. He was readmitted on July 25, 1942, with a recurrence of pain for four months, and a big mass was palpable in the epigastrium. Barium meal and gastroscopy confirmed the presence of a carcinoma on the anterior wall and greater curve, and at operation a large inoperable mass was seen in the stomach, with secondaries in the liver.

Case 2.—A man aged 62 was admitted on May 3, 1942, with a history of intermittent epigastric pain and flatulence for eight years "not bad enough to worry about," and severe pain for four months, much worse one day. At operation an extensive

†In England and Wales in 1947, 7,851 male deaths and 6,243 female deaths were recorded as being due to carcinoma of the stomach.

area of induration $2\frac{1}{2}$ in. (6.35 cm.) in diameter, and containing a large perforation $\frac{1}{2}$ in. (1.27 cm.) in diameter was found in the pyloric antrum: the perforation was sutured. A test meal on May 20 revealed normal acidity, and gastroscopy on May 27 provided an excellent view of the antrum but no sign of an ulcer. It was, however, noted at the time that the pylorus was gaping slightly and that it might be a false pylorus due to spasm in the distal part of the antrum. Three weeks later, on discharge, the stools were still strongly positive for occult blood. He was readmitted on September 4, 1942, and died the same day. Post-mortem examination showed a huge ulcer crater on the lesser curve and anterior surface of the antrum, and direct infiltration of the liver. Microscopy showed carcinoma simplex.

Case 3.—A man aged 56 was admitted on September 22, 1942, with haematemesis and melaena. He had had epigastric pain two hours after meals for four weeks, and fifteen years previously had had a similar bout for four weeks. Both barium meal and gastroscopy indicated spasm in the pyloric antrum and it was noted gastroscopically that antral peristalsis was absent. A further barium meal on October 30 showed a fluid residue and a prepyloric deformity which "could be produced by a very large, shallow ulcer"; beyond this there was a duodenal ulcer. He was readmitted on November 6, when visible peristalsis was present. Perforation occurred on December 31, the day before a laparotomy had been arranged. At operation extensive thickening was found on the anterior surface of the antrum for $1\frac{1}{2}$ in. (3.8 cm.) round a small perforation. Though there was some suspicion of a neoplasm at operation, the perforation was simply sutured and a gastroenterostomy performed. Gastroscopy on January 27, 1943, showed a medium-sized ulcer in the antrum that was thought to be benign. He was readmitted on March 15, when a mass was palpable in the right hypochondrium. He died on April 4, 1943. Post-mortem examination revealed an ulcerated carcinoma in the pyloric region of the stomach with small nodular deposits throughout the peritoneum. Microscopy showed a scirrhus carcinoma.

Case 4.—A man aged 49 was admitted on August 17, 1944, with a history of epigastric pain two hours after meals for eight years and sudden severe pain for one day. A duodenal ulcer had been found radiologically at another hospital two years previously. At operation a large ulcer was found on the lesser curve of the stomach 2 in. (5 cm.) above the pylorus, containing a small perforation; the perforation was sutured. A test meal on September 4 showed normal acidity, and at gastroscopy on the 6th there appeared to be an almost healed ulcer on the lesser curve of the stomach just above the angulus. He was readmitted on April 30, 1946, with a recurrence of pain for six months. A barium meal on March 28, 1946, had shown an ulcer on the lesser curve just in the pyloric antrum; this was confirmed gastroscopically. A further gastroscopy on May 21 showed scarring of the lesser curve of the antrum, but the ulcer appeared to be healed. He was readmitted on August 12 complaining of continual pain since discharge. At operation a large ulcer $2\frac{1}{2}$ in. (6.35 cm.) in diameter was found near the lesser curve and adherent to the pancreas; there was also evidence of a healed duodenal ulcer. A partial gastrectomy was performed and microscopy revealed the presence of an adenocarcinoma. He died on February 17, 1947. Permission for a post-mortem examination was not obtained.

Case 5.—A man aged 34 was admitted on February 21, 1946, with epigastric pain after meals for eight months and severe pain for one day. At operation a large indurated ulcer was found high on the anterior wall, adherent to the under surface of the liver and containing a perforation $\frac{1}{4}$ in. (0.3 cm.) in diameter. The perforation was sutured. A test meal on March 7 showed hyperchlorhydria, and at gastroscopy a week later no ulcer could be seen. He attended the follow-up department for three months, during which time he remained symptom-free, but when seen again on October 8, 1947, he complained of recurrence of pain for eight months. A barium meal at this time showed no abnormality. A further barium meal on July 31, 1948, revealed a large ulcer high on the lesser curve with distortion of the neighbouring mucosa suggestive of

neoplasm, and he was advised admission. He failed to come into hospital until May 20, 1949, when a laparotomy was performed and a growth found just below the cardiac orifice infiltrating the left lobe of the liver. The stomach and part of the liver were resected and histological examination showed a scirrhus carcinoma.

Case 6.—A man aged 73 was admitted on December 13, 1946, with a history of epigastric pain two to three hours after meals for six months and sudden severe pain for six hours. At operation a perforation was found high on the anterior surface of the stomach near the lesser curve; the perforation was sutured. A test meal on January 4, 1947, showed achlorhydria. He was discharged on February 5 and was seen again in the out-patient department on September 6, 1948, when a mass was palpable in the epigastrium. A barium meal on October 1 revealed an extensive neoplasm of the fundus and body of the stomach with involvement of the lower oesophagus. He died on December 24, 1948, and post-mortem examination revealed a leather-bottle stomach, the whole stomach and lower 2-3 cm. of the oesophagus being involved.

Case 7.—A man aged 49 was admitted on August 14, 1947, with epigastric pain worse four hours after meals for six months, and severe pain of sudden onset for one day. At operation a large saddle-shaped ulcer was found on the middle of the lesser curve penetrating the pancreas posteriorly and with an anterior perforation $\frac{1}{4}$ in. (0.6 cm.) in diameter; the perforation was sutured. A barium meal as an out-patient on October 13 revealed a large ulcer on the middle of the lesser curve, above which there was an hour-glass constriction. He was readmitted on October 31, after one month's vomiting. At gastroscopy one week later there was seen to be an unusual mid-gastric constriction with a heaping up of the mucosa suggesting carcinoma. At operation on November 12 a gastric mass was felt, suggestive of carcinoma, but the patient's poor general condition prevented resection. He died on January 16, 1948, and at necropsy a scirrhus carcinoma of the pylorus was found, invading the pancreas and extending up to the middle of the body of the stomach, producing an hour-glass constriction at the upper end and pyloric stenosis at the lower.

Case 8.—A man aged 64 was first admitted on April 1, 1948, with four weeks' history of epigastric pain after meals and a palpable mass in the right hypochondrium. He refused investigation and was discharged with a clinical diagnosis of carcinoma of the stomach. He was readmitted on April 20 with severe pain of one day's duration. At operation a large perforated ulcer was found at the pylorus, which was considered to be benign and was therefore sutured. At gastroscopy on May 6, 1949, a large carcinomatous ulcer was seen on the lesser curve of the antrum. He at first refused operation, but eventually agreed, and a laparotomy was performed on August 3, when an inoperable carcinoma was found in the pyloric region of the stomach adherent to the liver and the pancreas.

Discussion

It is difficult to compare the results in this series with others, as most published series of perforated ulcers specifically exclude carcinomas. However, Judin (1937) recognized 3 carcinomas in 272 perforations. Raw (1944) 3 in 315, and Lenormant (1942) 10 in 185. A follow-up is not always reported in published series, and it is possible that the incidence of misdiagnosis has been, if not as high as the present one, at least appreciable. For example, isolated instances have been reported by Smets and Henrotin (1947) and by Williams (1944).

That misdiagnosis is easy is stressed in all the reports in the literature. Bisgard and Overmiller (1944) reviewed 217 perforated gastric carcinomas and found that the diagnosis had been made preoperatively in only seven instances. They commented that: "More astonishing was the failure, in the majority of instances, to recognize at operation that perforation had occurred in a carcinomatous crater instead of a benign peptic ulcer. . . . The failure to recognize the

presence of the carcinoma suggests that the majority of carcinomas which perforate are small and relatively confined lesions, presumably suitable for resection." Black and Blackford (1945) considered that it was often impossible to distinguish the two conditions macroscopically. It is therefore reasonable to believe that the present experience is not exceptional.

On the other hand, it may be said that these cases merely illustrate the difficulty that always exists in differentiating benign and malignant ulcers of the stomach—a difficulty much stressed in America. However, in our experience, patients who have presented with haematemesis or pain and in whom a confident diagnosis of simple gastric ulcer has been made have not returned with carcinoma as often as in the present series; it was because of the striking difference of the experience with perforated ulcers that the series has been collected.

Reviewing the cases individually, it seems that an error of judgment was made in two (Cases 2 and 3) and that two others were inadequately followed up (Cases 6 and 7). The remaining three, however, were watched until what appeared to be satisfactory healing was observed by gastroscopy, so that close follow-up is not in itself an adequate precaution.

Analysis by age and sex shows that the observed misdiagnoses were confined to men over 30. The literature does not generally record in detail the cases which were misdiagnosed at operation, most of the individually reported cases being those which the authors recognized as carcinomatous. Detailed records have been found in only four instances (Chapuy and Jeune, 1936; McKechnie and Priestley, 1937; Dickinson, 1939; Ives, 1949). These were all in men aged 40–60.

Carcinomatous perforations certainly occur in women—a quarter of Aird's collected series were female—but the type which is apt to be mistaken for a simple gastric ulcer has so far been reported only in men. A possible explanation of this sex difference may lie in the fact that simple ulcers are relatively more likely to perforate in men than in women; for example, the sex ratio for perforated ulcers shown in Table II is 12:1, whereas the sex ratio for all ulcers at the same hospital is 5:1 (Avery Jones and Pollak, 1945). It is possible that the early carcinoma creates an area of decreased resistance to peptic digestion and permits the development of a secondary simple ulcer in which perforation may be expected to occur on occasion as well as in the carcinoma itself. If this is so, the ease of misdiagnosis can be explained as well as the peculiar sex ratio.

Analysis by site is not helpful except in showing that the risk of carcinoma is present in all parts of the stomach, and that perforations near the greater curve should always be treated as malignant. In the four cases in the literature, mentioned above, the perforations were described as being at or near the pylorus; but it would be unwise to lay stress on this site to the exclusion of the rest of the stomach.

It can be concluded that, if errors are to be avoided, special attention must be paid to the whole group of perforated gastric ulcers in men. Increased awareness of the possibility of carcinoma may result in the recognition of some cases that would otherwise be missed, but if the hypothesis is true that early carcinoma may give rise to superimposed simple ulcers some errors will continue to be made. Even routine biopsy at the time of operation cannot be relied on, as carcinoma might not be present in all parts of the periphery of the perforation. Such an event has, indeed, been reported by Williams (1944).

There remains the possibility of treating the perforation by immediate gastrectomy. It is not desired to enter into a full discussion of the merits and demerits of this procedure, but it must be remembered that the stomach is more mobile and easier to resect in perforated ulcers, which are mostly anterior and in the distal half of the stomach, than it is in the average ulcer which comes to operation for intractable pain. Many large series of perforations treated by gastrectomy have been published. DeBaKey (1940) collected 2,392 cases with a case mortality of 13.4%. Undoubtedly the patients subjected to gastrectomy were selected for their good initial condition, and it is not fair to compare these results with the average case mortality of 25.9% found by DeBaKey for cases treated by simple closure. However, Judin (1937) was able to report a case mortality of 12.6% for a total of 418 perforations coming to operation, of which 75% were treated by immediate gastrectomy.

Since then, advances in surgery and anaesthesia have greatly reduced the mortality of perforations, but this is not an argument against the major procedure, the danger from which has been similarly reduced. When it is remembered that the case mortality of perforated gastric ulcers is greater than that for duodenal ulcers, that 50% have severe relapses and 20% further major complications within five years (Illingworth, Scott, and Jamieson, 1946), an appreciable added risk of carcinoma must make immediate resection worthy of serious consideration in the limited group of perforated gastric ulcers in men over 30.

Summary

Seventeen cases of perforated carcinoma of the stomach are reported. Eleven occurred among 452 persons operated upon for perforation of the stomach or duodenum; eight were initially considered to be benign.

Of 86 perforations in men, diagnosed as being simple gastric ulcers at operation, seven (8.1%) proved to be malignant within three years.

Post-operative investigation is not enough to ensure that malignant cases are recognized before discharge from hospital, and it is suggested that the risk of carcinoma is an important reason for considering partial gastrectomy as the treatment for perforated gastric ulcers in men over 30.

I am grateful to Dr. F. Avery Jones and my surgical colleagues for permission to publish these cases, and to Dr. F. Avery Jones, Mr. J. D. Fergusson, Mr. T. G. I. James, and Dr. D. D. Reid for advice in the preparation of the paper. I am also grateful to Miss B. White for her great help in the collection of the material.

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