ulceration may indeed have peptic ulcers as in the present case. Eight additional cases associated with peptic ulcers have been recorded (gastric 3, duodenal 5). Four further patients had a history of haematemesis or melaena. Acute haemorrhagic pancreatitis is a rare presentation, but has been recorded.

Differential Diagnosis.—The diagnosis has been suggested pre-operatively in eight cases. It will be considered only when there is a sufficient degree of deformity or obstruction to be shown by a barium-meal examination. Other possibilities to consider include congenital bands associated with malrotation, tumours of the pancreas or sphincter of Oddi, ulcer and rarely primary or secondary cancer of the second part of the duodenum, and pressure by enlarged glands from without.

Treatment.—If surgical treatment is indicated the choice of procedure lies between section of the ring and some form of by-pass operation. The former carries some risk of fistula formation, and so the site of division should be protected by a drain to the exterior. This may be combined with longitudinal division and transverse suturing of the duodenum, the suturing being made in such a way as to drain the cut ends of the pancreatic annulus into the lumen. This duodenoplasty overcomes any intrinsic duodenal narrowing and the possibility of recurrent obstruction. Partial gastrectomy is a somewhat severe method of dealing with an annular pancreas unassociated with other gastro-duodenal disease. Gastro-jejunostomy introduces an undoubted risk of stomal ulceration, and, if feasible, duodeno-jejunostomy would be preferable.

Summary

A case of annular pancreas is reported. The finding was an incidental one at operation for chronic duodenal ulcer. No obstruction of the duodenum was produced, and the presence of the condition did not affect the operative treatment of the ulcer.

We are indebted to Drs. R. Quilliam and A. Jenkins for the radiological reports and to Mrs. Mace for the picture.

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SLIDING HERNIAS THROUGH THE OESOPHAGEAL HIATUS

BY

G. RIOS-SOLANS, M.D.*

(From the Gardiner Institute of Medicine, University of Glasgow)

[WITH SPECIAL PLATE]

The anatomical abnormality of hernia through the diaphragm was first referred to in 1570 by Ambroise Paré, who noticed the condition at a post-mortem examination and attributed it to trauma. Fothergill (1746) described a congenital variety. The first diagnosis during life was made by Newman (1888), who also performed the first operation for its cure. Akerlund (1933) made a careful study of all types of diaphragmatic hernia, and his classification has formed the basis for much subsequent work. In recent years the frequency of diaphragmatic or hiatus hernia has been fully recognized, and there are many publications available on the subject.

*Working as a scholar from Spain under the British Council.

The present paper deals with only one variety of hiatus hernia, the so-called "sliding hernia," which is the commonest of all, and which has been excellently described by Allison (1951). A sliding hiatal hernia is chiefly encountered in adults who are past middle age, and must therefore be regarded as quite distinct from a congenital defect. In considering its aetiology, two matters appear to be of prime importance: (1) the exact anatomical status of the so-called "cardia," or junction between oesophagus and stomach; and (2) the part played, structural and physiological, by the terminal part of the oesophagus as it passes through the diaphragm.

The So-called "Cardia"

In a study of the cardia, clarity in certain anatomical points is essential: (a) the nature of the boundary between the oesophageal and gastric mucous membranes; (b) the normal relationship of the boundary of the two mucous membranes to the exit through the diaphragm; (c) the question of a real anatomical sphincter at or close to the boundary; and (d) the site of the change in shape from tubular (oesophagus) to saccular form (stomach). These points can be made out only by careful microscopical examination of the whole zone in specimens removed in the post-mortem room and fixed by most careful technique to preserve and identify exact relationships. Macroscopic methods such as changes in colour, difference of shape, and even x-ray films taken during life are not exact enough, and may indeed be very misleading. Oesophageal structure is clearly identified microscopically by its stratified squamous epithelium, and stomach structure by its characteristic mucous membrane. Microscopical investigation clearly shows that the junction of the two mucous membranes is not a ring, but follows an irregular curve. Moreover, although the junction of the two mucous membranes is clean-cut, it is not unusual to find areas of gastric mucosal glands lying below the stratified oesophageal lining membrane. The opposite, however, does not occur.

In the photomicrograph (see Plate) this transition is clearly seen, and the two muscular layers are also well demonstrated. The point should also be noted, as has been found microscopically, that the diaphragmatic muscle does not clasp the oesophagus at a fixed level or point—there is an agglomeration of muscle fibres and loose fibrous tissue which allows the oesophagus to slide up and down for a short distance, this being essential for the normal respiratory movement of the diaphragm. In what may here be termed normal cases, accurate marking showed that the level of the diaphragmatic insertion and the junction of the two mucosae never coincided. Oesophageal stratified epithelium was always found at this level, indicating that the normal junction is below the diaphragm and just above the point where the saccular expansion of the stomach begins. This explains the curious observation that carcinoma of the fornix of the stomach extends to the cardia. That is to say, it invades the lowest tubular portion, with resultant incompetence or stenosis. No observation has been made of a carcinoma of the oesophagus (properly called) subsequently invading the fornix. It would seem, therefore, that a tumour always infiltrates the same structure and the change of lining membrane constitutes a barrier. A gastric carcinoma which invades the lowest tubular part invades its own structure, not the oesophagus.

Terminal Part of the Oesophagus

No evidence was found microscopically of any true muscular sphincter at the lower end of the oesophagus. As has been stated, the joining line between the two mucosae is an irregular curve and never a ring, and a ring form would almost be required for a true muscular sphincter. Thus, as Barrett (1952) has pointed out, the cardia and sphincter mechanism are not synonymous.

Lendrum (1937), in a careful anatomical study of the cardia in 150 cases, also concluded that no ring-shaped muscular reinforcement was present. No muscular thickening was found in the present investigation. Although there is thus no obvious and clearly defined muscular sphincter, this does not exclude some potential sphincter mechanism of a kind less positive than, for instance, the pylorus of the stomach. I believe that a segment of the oesophagus, extending for about 1 in. (2.5 cm.) above the stomach, may act as a sphincter. This view is supported by our knowledge of cardiospasm (first described by Purton in 1821), in which there is no ring of closure but a narrowing over about 1 in. (2.5 cm.) of the tube. This, indeed, is the basis of Heller's operation, with an incision in the oesophagus about 1 in. (2.5 cm.) in length.

There are many other views concerning a potential sphincter mechanism between oesophagus and stomach, and the action is often nowadays referred to as resembling a "pinch-cock"—generally adequate, but easily overcome to permit regurgitation. Lendrum (1937) has even suggested that muscular fasciculae in the stomach wall may on contraction contribute to a sphincter action, but this view has not received support. As Alvarez (1939) points out, the diaphragm will act as a sphincter when the intra-abdominal pressure is very high. Its action cannot be important, however, since patients with patency of the hiatus or hiatus hernia do not have continuous regurgitation.

The sphincter action, such as it is, is clearly under nervous control by Auerbach's plexus and by the sympathetic and parasympathetic systems.

Patency of the Oesophageal Hiatus

The question of patency of the hiatus was investigated in the post-mortem room of the Western Infirmary in 50 consecutive necropsies, in adults between the ages of 31 and 78 years. A finger—sometimes two fingers—was inserted into the hiatal region from the abdomen, and cases in which one or two fingers could be inserted for a distance of 2–3 cm. are described as *positive*, and the others as *negative* (see Table). Cases in which an operation had been performed in

Summary of 50 Consecutive Necropsies

Case No.	Age	Sex		Case No.	Age	Sex	
1	40	F	+	26	61	M	+
2	63	F	—	27	61	F	—
3	45	M	—	28	64	F	—
4	51	M	—	29	52	M	—
5	78	M	+	30	52	F	—
6	60	M	—	31	72	M	—
7	52	M	—	32	72	M	+
8	65	M	—	33	47	F	—
9	65	F	—	34	62	F	+
10	66	F	+	35	45	M	—
11	37	M	—	36	35	F	—
12	77	M	—	37	61	F	—
13	59	M	—	38	55	F	+
14	55	M	—	39	54	M	—
15	55	F	—	40	31	M	—
16	37	F	—	41	78	M	—
17	69	M	—	42	75	M	+
18	62	M	+	43	64	M	—
19	75	M	+	44	55	M	—
20	60	M	—	45	59	M	—
21	68	F	—	46	49	F	—
22	60	M	+	47	53	M	+
23	64	F	—	48	73	M	—
24	73	M	—	49	35	F	—
25	73	F	—	50	64	M	+

the area of the stomach or adjacent parts were excluded. The Table shows that in 13 of the 50 cases examined (26%) the hiatus was to some extent open so that herniation above the diaphragm would easily be possible. It is not thought that the laxity of tissues in the cadaver would account for this, in view of the numerous negative results. It must be remembered that three important structures pass through the diaphragm close to one another—the aorta, the inferior vena cava, and the oesophagus. The first two openings are always firmly closed, so that herniation is virtually impossible; it is only the oesophageal opening which is not.

The oesophageal passage is elliptical in shape, to allow for considerable distension of the oesophageal tube as food passes through it, and the extra space is filled up by loose fibrous tissues. Here is obviously a weak spot in the separation of the abdominal and thoracic cavities.

In the series of cases referred to, patency was found only in the anterior and left lateral part of the hiatus, and never in the posterior and right lateral part, although loose fibrous tissue surrounds the oesophagus on every side. The reason is clearly because (Gray, 1926) only the anterior and left side is covered by peritoneum on the abdominal side, and it is only in such a place that a sliding herniation can arise.

X-ray Findings Compared with Post-mortem Findings

Johnstone (1952) and Pickard (1952) have both reported a surprising number of hiatus hernias during routine x-ray examination of the gastro-intestinal tract, but only when the patient is placed in the "head-down and feet-up position," as first recommended by Soresi in 1919. Pickard's percentage in such x-ray examinations was 11%, in contrast with 26% in my series of post-mortem observations. There must be some reason for this discrepancy, and it is suggested that it is only when patency is well marked that the hernia appears during x-ray examination.

Summary

An investigation has been made of various points concerning the aetiology of the "sliding" type of hiatus hernia.

It was evident that before reaching any conclusion a careful study of the so-called "cardia" was essential—that is to say, of the junction between oesophagus and stomach and of the passage of the oesophagus through the diaphragm.

The results of macroscopic and microscopical examinations of this area are given in detail.

There is no clearly defined anatomical sphincter at the lower end of the oesophagus, and the squamous lining ends in an irregular curve and not in a ring. This, however, does not exclude a broad but weak contractile mechanism in the lower part of the oesophagus.

In an unselected series of adults carefully examined in the post-mortem room, patency of the hiatus was detected in 26%. This finding has been interpreted as evidence of potential hiatus hernia. The patency was always found at the anterior and left lateral part of the passage of the oesophagus through the diaphragm.

This investigation was carried out during the tenure of a British Council Scholarship. I am indebted to Professor Sir John McNee for help and guidance, and also to Professor D. F. Cappell and his staff for many facilities in the department of pathology at the Western Infirmary, Glasgow.

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A recent survey by the National Agricultural Advisory Service has shown that washed eggs are specially likely to go bad after storage. This is an important factor, since the survey also revealed that an average of one egg in three is soiled in the nest. Research into this problem is being carried out by the Food Investigation Organization.

H. PAYLING WRIGHT, M. M. KUBIK, AND M. HAYDEN:
RECANALIZATION OF THROMBOSED ARTERIES UNDER ANTICOAGULANT THERAPY

FIG. 1.—Femoral arteriograms from rabbit treated with anticoagulant. A, Complete occlusion 24 hours after thrombosing. B, Three weeks later, artery again patent.

FIG. 2.—Femoral arteriograms from control rabbit. A, Complete occlusion 24 hours after thrombosing. B, Thirteen weeks later, artery still occluded. Development of collateral vessels is marked.

FIG. 3.—Section through femoral artery of treated rabbit at level of thrombus after patency has been restored. ($\times 64$.)

FIG. 4.—Section through femoral artery of control rabbit at level of occlusion. ($\times 64$.)

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Section showing junction of stratified squamous lining of oesophagus and mucous membrane of stomach. ($\times 33$.)