DIVERTICULOSIS AND DIVERTICULITIS OF THE INTESTINE

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Introductory

Primary diverticula of the small and large intestine are acquired by a process of herniation of the mucosa through the muscle coat of the bowel and are an affection of middle age and later. The mechanism, as with herniation through the abdominal piaeties, is exceedingly complex and little understood. It is generally agreed that two basic factors are concerned—pressure within the cavity of the bowel, which forces the mucosa against the muscularis; and an outlet, or locus minoris resistentiae, such as that provided by the gap in the muscle coat occasioned by the passage of blood vessels or, in the case of the duodenum, by the common bile duct. The unknown factor lies in the behaviour of the plain muscle itself, upon which layer the integrity of the bowel wall depends. It has been demonstrated that atonicity or atrophy of the muscle is not a constant, or even a common, causal factor. Not only does the microscopic anatomy bear evidence against such a supposition, but it is well known that passive pressure alone, as in acute obstruction, does not produce pouching. It has been suggested that local spasticity of the muscle wall is a more probable antecedent to herniation, and there the matter rests. All those contributory factors which arrive coincidentally with middle age, and which predispose to external abdominal herniae, are doubtless concerned and the tendency to diverticulosis increases progressively with age.

Anatomy

The muscle coat of the intestine usually ends abruptly at the orifice through which the mucosa is extruded, though it may be everted to accompany the hernia for a short distance. The muscularis mucosae accompanies the mucous membrane, so that a few fibres may be present throughout the diverticulum, although in the fully-formed diverticulum the fundus usually consists of mucous membrane covered only by the serosa. Occasionally, more especially in jejunal diverticula, there may be some evidence of compensatory hypertrophy of the muscularis mucosae in the wall of the pouch.

The vessel whose channel through the muscular coat determined the site of herniation can usually be demonstrated. In the small intestine the blood vessels pass through the muscle coat almost immediately they leave the mesentery, hence the diverticula are closely related to the latter; in the colon the blood vessels, after leaving the mesentery, pass under the serous coat to the edge of the longitudinal muscle band before piercing the circular coat to reach the submucosa. Hence diverticula of the colon appear in two rows on either side of the mesentery and at some distance from it. As the blood vessel passes under the longitudinal muscle of the colon a small branch is given off to the corresponding taeniae epiploicae; thus in obese subjects the pouches are often obscured by fat.

At first the diverticulum is conical in shape, but eventually, when fully formed, is globular, its mouth being narrower than its maximum diameter. In the duodenum and jejunum the pouch may become very large—of golf ball size and over—but in the colon the size rarely exceeds that of a small grape.

Situation

The most common sites for diverticula are the sigmoid colon, the duodenum and the upper jejunum, in that order. It is not uncommon to find diverticula in all three sites in the same individual. Radiological evidence of the coexistence of diverticula of the colon was present in 17 of a consecutive series of 80 cases of diverticula of the second part of the duodenum (21 per cent.), against an anticipated incidence of approximately 12 per cent. in normal people of the same age group.

Clinical Aspect

The underlying cause for clinical symptoms due to diverticula is retention of intestinal contents, to which they are predisposed by their deficient muscularature and their bottle-neck communication.
with the parent intestine. The nature of both symptoms and complications will thus depend largely upon the nature of the contents and the anatomy of the area of bowel from which the diverticula arise.

The Duodenum

Hernial diverticula of the duodenum are to be found in about 2 per cent. of all radiological examinations of the gastrointestinal tract, and about 80 per cent. of these appear at the site of entry of the common bile duct into the duodenum, and are hence called perivaterian. Except when situated at the duodeno-jejunal flexure, duodenal diverticula other than perivaterian very rarely give rise to symptoms.

The first part of the duodenum is never the seat of hernial diverticula and pouching in this situation is the result of chronic duodenal ulceration. The affected part of the duodenum is shortened by contraction of scar tissue due to ulceration and the unaffected unscarred portion of the duodenum balloons outwards. Though evidence of attenuation of the muscular wall may be found at the fundus of such pouches when they are large and of long standing, in the early stages their wall is normal. They never give rise to symptoms per se and their significance lies in furnishing absolute evidence of past or present chronic duodenal ulceration.

Perivaterian diverticula. These pouches, which are usually single, nearly always arise in posterior relationship to the common bile duct and pass to the left behind the head of the pancreas, being separated from the latter by a layer of areolar tissue. Many of the patients are viscerotic. The diverticula do not give rise to recognizable symptoms until they have enlarged sufficiently to retain duodenal contents for a significant period. The symptoms are then those of a flatulent dyspepsia, with a sense of oppression in the epigastrium after meals, and borborygmi. Pain is not a common symptom. The mimicry of chronic cholecystitis is particularly close and acquired diaphragmatic hernia may also produce similar symptoms. It must be stressed always that, unless there is unequivocal evidence of delay in the diverticulum, the latter should not be regarded as the cause of the symptoms.

Perforation of a perivaterian diverticulum is almost unknown, but other complications are recorded, e.g. chronic pancreatitis, obstructive jaundice. Seldom, however, can diverticula be held responsible for either and any association between the two is likely to be coincidental.

Management. It is probably advisable to ignore the presence of a small duodenal diverticulum discovered by barium meal. Knowledge of its existence is of no material value to the patient and there is no known treatment which can influence it in
any way. Operation should be considered only when the diverticulum retains barium after the stomach has been empty for several hours and is of large size. In only three of a series of 80 patients in whom a perivaterian diverticulum was revealed by radiography could the author regard them as a probable cause of the symptoms. In all three barium was retained from 18 to 36 hours after the stomach had emptied. (Figs. 1a and b).

**Diverticula at the duodeno-jejunal flexure.** Diverticula here tend to increase in size quickly, probably because their mouth is at the acute turn of the bowel, and they are thus placed at a great mechanical disadvantage. They tend to burrow to the right underneath the peritoneum and when of large size may cause intermittent duodenal obstruction. For this reason operation for their removal should usually be undertaken.

**Operation.** To remove a perivaterian diverticulum it is necessary to mobilize the duodenum and roll it over to the left, when the pouch comes into view. A finger placed into the pouch through a small opening in the anterior wall of the duodenum will assist if difficulty is met in separation from the pancreas. The common bile duct must be exposed to ensure that it is not violated and the pouch cut away after sealing its mouth with a clamp. Repair by two layers of catgut is recommended. The removal of a pouch from the neighbourhood of the duodeno-jejunal region is facilitated by division of the ligament of Treitz, after identifying and safeguarding the inferior mesenteric vein.

**The Jejunum**

Divertica are less common in the jejunum than the duodenum, probably because of the part played in the formation of the latter by the common bile duct. The condition is one of progressive diverticulosis, with multiple pouches, which spreads down the bowel, rarely reaching the ileum; it resembles diverticulosis of the colon in this tendency to progression. In old people many hundreds of pouches may be found.

The symptoms caused are similar to those caused by perivaterian diverticula, but may be even more pronounced, especially as far as borborygmi are concerned. In addition, however, when large—and they may grow to the size of a tangerine—they tend to cause intermittent jejunal obstruction, with hypertrophy of the jejunal wall. The diverticula may occasionally become acutely inflamed and may, rarely, perforate. Spontaneous haemorrhage has also been recorded.
The Colon

Diverticulosis of the colon is the commonest radiological abnormality of the large bowel in subjects over 45. The condition was found in 254 of 2,139 consecutive barium enema examinations during a 13½-year period at King's College Hospital, an incidence of 12 per cent. If examinations on patients of under 35 years are excluded, the figures are 251 in 1,623 examinations, an incidence of 16 per cent. Although occasionally a few isolated pouches irregularly spaced throughout the bowel may be revealed by X-ray, diverticulosis of the colon in its common and characteristic form is a progressive disorder, which commences in the sigmoid and spreads throughout the colon, including, in the most advanced cases, both the vermiform appendix at one extreme and the rectum at the other.

Radiology may reveal diverticula at an early stage in their development, a 'saw-edge' appearance being noted on the contour of the barium-filled colon, an appearance which Spriggs and Marxer call the 'pre-diverticular state.' At a later stage the pouches are funnel shaped, until finally the mucosa is blown out to a globular swelling forming about seven-eighths of a sphere. The long and narrow communication sometimes to be seen on X-ray, and giving the appearance of a grape on its stem, is due either to spasm of the muscularis at the orifice of the diverticulum or to thickening of the bowel wall at this site from chronic inflammation. Occasionally, even when there is no clinical evidence of diverticulitis, retention of faecal material in the pouches is revealed by X-ray (Fig. 3).

Diverticulitis. Excepting the caecum (q.v.), diverticulitis complicating diverticulosis is very rarely seen elsewhere than in the sigmoid. This is because: (a) the sigmoid is the starting place of diverticulosis of the colon; (b) the faeces here reach their maximum degree of solidity and thus retention in the pouches is favoured; (c) the length of stay of the faeces in the sigmoid is normally longer than elsewhere in the bowel; and (d) the sigmoid is the narrowest part of the colon.

It is very difficult to ascertain the incidence of diverticulitis, for the border line between what may be called a mild degree of diverticulitis and diverticulosis is often ill defined. Established recurrent diverticulitis (q.v.) is, however, comparatively rare. One unexplained fact in this connection is that, whereas diverticulosis shows little discrimination between the sexes, established chronic diverticulitis is at least two and a half times as common in men as it is in women.

Management of diverticulosis and diverticulitis of mild degree. The majority of patients with diver-
ticulosis go through life without suffering any untoward symptoms from that source. It is thus probably wisest if diverticulosis is revealed 'by accident,' and if there are no signs that any inflammation is present, not to make the patient aware of his condition. The most that should be done is to advise, from a general standpoint, avoidance of constipation. Regeneration in diet, which is a life sentence, should be reserved for those in whom there is already some evidence of diverticulitis, e.g. occasional pain or discomfort in the left iliac fossa, increasing irregularity of bowel action, radiological evidence of bowel spasm or rigidity and of faecal retention in the pouches. Treatment for such patients is based upon three factors: avoidance of constipation, elimination of indigestible foods from the diet, and bowel lavage.

The complications. The surgeon is chiefly concerned with the complications of diverticulosis. These may be conveniently summarized as follows, though the scheme suffers from failure to indicate the infinite shades in degree of chronic diverticulitis:

- **Chronic diverticulitis with recurrent exacerbations.** The process is a continuous one, marked by periods of exacerbation in which are presented all the signs and symptoms and constitutional disturbances attendant upon the presence of an inflammatory mass in the left iliac fossa, sometimes including the passage of blood. This clinical state is the usual prelude to perforation, to abscess formation, to fistula formation, and to obstruction.

It is generally held that the role of the surgeon only begins when one or other of these serious complications has developed. Accumulated experience of the fate of those who come to surgery late, or for whom palliative colostomy has been performed, has given rise to misgivings as to whether this conservatism is always justified. With the perfection of those new methods which have so greatly increased the safety of intestinal surgery it is necessary to take fresh stock of the situation. Resection of the inflammatory mass during a quiescent period, and when the process is yet young, is an attractive and effective alternative to some palliative procedure deferred until the disease is long established and the dangers of radical operation increased by the grosser nature of the lesion and the added years of the patient.

There is called for, not so much a categorical formula for treatment, but a change of attitude from 'let us await complications before surgery' into 'let us circumvent complications by surgery.' The fate of many patients who have been subjected to colostomy as the sole treatment of diverticulitis, including its complications, bear evidence that its use should rarely, if ever, be entertained, except as a preliminary to a radical operation.

The ideal procedure is segmental resection of the affected area and restoration of continuity by immediate end-to-end anastomosis, with Paul's operation as an alternative possibility. A temporary proximal colostomy should normally precede resection by some months.

**Diverticulitis during an acute exacerbation.** It is important to envisage the probability of the presence of an abscess in the peri-colic tissue during an acute exacerbation and by treatment to endeavour to prevent its spread. There may be

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**FIG. 3.—A series of diagrams compiled from radiographs illustrating the stages of diverticulosis.** (a and b) Spasticity of the colon with irregular indentations between the haustra, which are themselves irregular. (c and d) The pre-diverticular state (saw-edge colon). (e) Club-shaped diverticular. (f) Fully-formed, flask-shaped diverticula. (g) Various appearances given by retention of faeces in the diverticula.
occasions when the surgeon is tempted to consider operation and exteriorization should he feel that perforation is imminent, but, on the whole, he will be best advised to delay interference and treat the patient by rest in bed, a fluid diet, and antibiotics, of which streptomycin is probably the most effective. At this stage aperients and lavage must be avoided.

Perforation and peritonitis. Perforation may be the first indication of the presence of diverticula in the bowel in the younger age group. A violent seizure of acute pain is followed by evidence of spreading peritonitis, which should lead to immediate laparotomy. The greatest danger is in delay. Perforation is, however, more commonly a complication of the established condition and may be the climax of a severe exacerbation of diverticulitis. At operation a thickened and greatly inflamed colon is then found and, though pus and faecal material and foul-smelling gas are discovered on opening the abdomen, it may be impossible to find the actual perforation. In some such cases the peritonitis is doubtless due to rupture into the peritoneum of a pericolic abscess and the communication of the latter with the lumen of the bowel may have become sealed off.

Occasionally perforation into the peritoneal cavity, particularly in long-standing cases of diverticulitis, may cause very mild symptoms, there being little inflammatory reaction by the peritoneum. The explanation for this is not known.

The prospect of recovery after early operation for perforation will vary with the length of history of diverticulitis which precedes the catastrophe and with the degree of pericolicitis revealed at operation. The prognosis after early operation in patients with no previous history, or a history of short duration, is excellent, for the bowel wall is still flexible and the perforation can readily be found and easily closed. The closure is reinforced by omentum and the pelvis drained. In some, recovery may be complete and the patient experience no further trouble; in others a sigmoido-cutaneous fistula may develop (q.v.).

The real problem is in the surgical management of those cases in which there has been a long history of recurrent attacks of diverticulitis and in which at exploration the bowel is found to be immensely thickened and congested, and particularly in those in whom the actual point of perforation cannot be identified. In such an event the safest procedure is to exteriorize the bowel, if this is practicable. An alternative is to attempt to seal off the inflamed area with pericolic fat and omentum; in the old and the very ill patient the operation may need to be restricted to this procedure. In others, in whom there is a prospect of subsequent resection, a transverse diversional colostomy should be performed at the same time. In either event the peritoneal cavity should be drained and antibiotics given.

Abscess. Abscess formation is a very common accompaniment of recurrent diverticulitis. The abscess may be small and may not give clinical evidence of its presence, but remain buried in a thick mass of pericolic fibrous tissue. It may, however, develop quickly and form a large collection of pus under tension seeking an exit. It may burst into the peritoneal cavity, into a neighbouring hollow organ, or into the abdominal parieties on the left side. The bursting of an abscess into the peritoneal cavity usually causes acute spreading peritonitis, demanding immediate operation, the method of operative procedure being as for perforated diverticulum. The outlook for such cases is grave. Occasionally, however, evidence of rupture of an abscess may be slight and may cause little peritoneal reaction. Rupture of an abscess into neighbouring bowel may result in spontaneous relief from symptoms. Rupture into one of the female pelvic organs, and even into the ureter, has been described, but the commonest organ to be affected is the bladder, with later development of sigmoido-vesical fistula.

The appearance of an abscess underneath the abdominal parieties is self-evident and the treatment should be immediate drainage without any direct attack upon the bowel. Drainage of such an abscess usually results in relief from the acute diverticulitis, but a fistula will probably persist through the drainage wound (sigmoido-cutaneous fistula). Occasionally an abscess may develop in the parieties insidiously without any preceding history of a severe attack of diverticulitis and closely resembling a cold abscess due to tuberculous disease.

Sigmoido-cutaneous fistula. Fistulae on to the skin, which may sometimes be multiple, are rarely spontaneous, but usually develop after opening an acute abscess, after operation for perforation, or as a complication of radical operation upon sigmoido-vesical fistulae. Those following drainage of an abscess tend to heal spontaneously and the question of operation should, therefore, in any case, be deferred for several months. A decision will finally be needed as to whether the fistula should be allowed to remain or an attempt at cure be made. The latter must be of a radical nature, with excision of the affected bowel, for no compromise is permissible between doing nothing and the radical operation.

The decision to operate will rest mainly upon the age and general condition of the patient. The fistula may cause little inconvenience and may be well tolerated by the patient, especially if old. Its presence acts, in fact, as an insurance of some
degree against the development of further inflammatory masses. In the younger age group, and in those who find the presence of a fistula embarrassing and irksome, radical operation should usually be attempted. At the present day the procedure is a safe one and the only serious risk is a recurrence of the fistula as a result of leakage from the suture line. Though it is possible sometimes to do the operation in one stage, it is usually expedient to precede the excision by a transverse colostomy, allowing some two to three months between the two operations.

**Sigmoido-vesical fistula.** Diverticulitis is the commonest cause of sigmoido-vesical fistula. Usually it is a complication of recurrent diverticulitis which has been a cause of ill health for some years, though it sometimes occurs in the younger age group following a short history of diverticulitis. In 15 cases the average duration of symptoms of diverticulitis preceding the development of a fistula in the bladder was three years and nine months.

The history varies considerably, but usually the formation of a fistula is preceded by an acute attack of diverticulitis, with pyrexia, the appearance of a tender mass low down on the left iliac fossa and frequency of micturition. The tender mass is due to an abscess, which eventually ruptures into the bladder, with immediate relief of the acute abdominal symptoms, but exacerbation of urinary symptoms. There is severe vesical pain, with intense frequency, and the urine is heavily laden with faecal-smelling pus. There may also be haematuria. Gas, followed by faeces, may not appear for some days, though a week or more may pass. In one case pneumaturia was not established as a regular feature until after many months. The interval between the rupture of the abscess and the presence of faeces will depend upon the length of time it has taken to establish a fistulous track.

The acute bladder symptoms tend to subside quite quickly and may eventually disappear. After some weeks the bladder mucosa, except at the site of the fistula, will return to a normal cystoscopic appearance. After the initial outpouring of faeces the fistula is liable to close sufficiently to prevent any further escape of semi-solid material, except as an occasional incident, and the main symptom will therefore be the passage of gas per urethram.

Ascending infection of the kidney is rare and this should be taken into account when considering treatment. Once a fistula has declared itself it is wise to defer any question of operative treatment for some months, in order to allow the pericolic inflammation to subside and to allow the bladder to establish immunity. Furthermore, the fistula may, rarely, heal spontaneously.

The criteria for operation are similar to those governing sigmoldo-cutaneous fistulae, with perhaps a little more emphasis upon conservatism. There should be no compromise between non-interference and radical cure. Colostomy alone is an infliction and not a cure and should be rigidly avoided, for it adds to the patient's discomfort without necessarily affecting the fistula.

Older people, and especially in those whose fistulae developed after a long history of recurrent diverticulitis, are best advised against radical operation, though selection of cases for operation is a matter of clinical judgment and cannot be the subject of any ex cathedra statements. Radical cure should certainly be entertained in the younger age group of patients, and especially in those in whom there has been no great length of history of diverticulitis before the fistula developed. The principle of a preliminary transverse colostomy preceding the radical operation by two to three months should usually be followed. Temporary supra-pubic drainage of the bladder after repair of the fistula and resection of the involved bowel is desirable.

**Obstruction.** The mass of fibrosis which develops around the inflamed sigmoid may be responsible for producing acute small intestine obstruction as a result of adhesions. This is a rare consequence, however, and the more likely result is a narrowing of the sigmoid from contraction of the scar tissue. The state of chronic obstruction which results may closely simulate carcinoma of the bowel. Diagnosis between the two is, in fact, not always possible, though the history and the radiological appearance, particularly if a double contrast enema is used, will usually enable the differential diagnosis to be made. It is necessary to emphasize that the presence of diverticula in the colon, as revealed by the radiograph, does not preclude the possibility of new growth, for, although there is no evidence of direct causal association between diverticulosis and cancer, both are common. In a series of 162 patients with diverticulosis, nine had radiological evidence of cancer of the bowel. In other words, the diverticulosis patient is neither more nor less liable to cancer of the bowel than is the normal subject.

It goes without saying that chronic obstruction due to diverticulitis will demand surgical relief. In older people, who are poor operative risks, a short-circuit operation around the area of the obstruction is an excellent alternative to any attempt at resection. Permanent colostomy should be avoided.

**Diverticulosis and Diverticulitis of the Caecum**

Diverticulitis of the caecum occupies a somewhat special place, for it differs from diverticulitis of the sigmoid colon in three particulars:
January 1953

C. S. NICOL: The Treatment of Neurosyphilis 27

1. The age incidence is lower.
2. The pouches are often solitary.
3. The pouches are peculiarly liable to cause acute symptoms. Acute diverticulitis of the caecum, which closely resembles acute appendicitis in its clinical features, may, in fact, be the first indication of the presence of a pouch. Rarely, chronic inflammation of a diverticulum causes a mass in the right iliac fossa which is liable to be mistaken for cancer and the true nature of which only comes to light after excision.

The management of a case of acute diverticulitis revealed at operation undertaken on a diagnosis of acute appendicitis will vary according to the findings. There have been cases recorded in which the infected diverticulum was readily seen and was excised. In others there is found a mass of inflammatory tissue and the wall of the caecum itself is acutely inflamed. The best procedure for the latter condition is to exteriorize the bowel, with subsequent excision and, finally, closure. This is a protracted and irksome experience for the patient, but there appears to be no alternative.

Diverticula of the Appendix

Diverticula of the appendix may be demonstrated in about 1/4 per cent. of appendices removed at operation. They may be associated with generalized diverticulosis of the colon or may result from disorganization of the appendix musculature as a result of chronic fibrosis. They are not in themselves of any notable clinical significance.

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THE TREATMENT OF NEUROSYPHILIS

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In a paper dealing with the treatment of neurosyphilis, it is first necessary to discuss briefly the incidence, clinical classification and natural history of the condition.

It is almost certain that 'invasion' of the nervous system by the treponema pallidum occurs during the primary stage of the disease in all cases, but in the majority these organisms do not survive to produce an inflammatory process, thus 'involvement' may occur in 25 to 35 per cent. of cases. This involvement is first manifested by a pleocytosis and increased protein content of the spinal fluid in the secondary stage of the disease as demonstrated by the pioneer work of Ravaut (1903). Even after involvement of the nervous system at this stage spontaneous regression occurs in a number of cases so that Bruusgaard's (1929) analysis of patients with untreated syphilis seen many years later, gave a figure of 9.5 per cent. for those with neurosyphilis, while Rosahn's (1946) analysis of autopsy findings in 77 patients with untreated syphilis showed pathological evidence of neurosyphilis in 7.6 per cent.

A classification of neurosyphilis is always difficult as the involvement of meninges, vessels and parenchyma never occurs alone, but one or other type usually predominates.

1. Early syphilis (within first four years of infection):
   (a) Asymptomatic neurosyphilis.
   (b) Acute syphilitic meningitis (may occur in secondary stage or later).

2. Late syphilis (after fourth year of infection):
   (a) Asymptomatic neurosyphilis.
   (b) Meningeal syphilis of brain or spinal cord (often termed meningo-vascular as there is also involvement of smaller vessels).
   (c) Vascular syphilis of brain or spinal cord (involvement of medium-sized vessels).
   (d) Parenchymatous:
      (i) General paresis.
      (ii) Tabes dorsalis.
      (iii) Optic atrophy.
   (e) Gumma of brain or spinal cord.

It is important to know something of the natural history of neurosyphilis and realize that reversal
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