PART I

It is generally held that diverticula of the colon are usually asymptomatic. Evidence for this is the frequency with which they are found incidentally during barium-enema examinations and at autopsy. Symptoms are usually produced when the diverticula become inflamed, and the orthodox view is that the surgery of diverticula is the surgery of the complications supervening on inflammation of these pouches. However, two very serious complications of diverticula of the colon, namely, massive haemorrhage and free perforation, may occur in association with no, or at the most minimal' inflammation. The review of 90 cases from the Johannesburg General Hospital presented here is thus concerned with those in which the clinical features were attributed to the diverticula, whether there was evidence of diverticulitis or not. The patients were all admitted to hospital and the series is a selected one in this sense only. Numerous patients in whom diverticula were discovered as an incidental finding, or who were not admitted to hospital, were not included in the survey.

The cases have been divided into 6 groups, according to their predominant clinical presentation. The groups are discussed under the headings of: (1) haemorrhage, (2) spreading peritonitis, (3) abdominal or pelvic mass, (4) fistula formation, (5) intestinal obstruction, and (6) 'uncomplicated' diverticulitis. With regard to the 'uncomplicated' group, it soon became apparent that the diagnosis of diverticulitis is far from easy, and that many cases were coded as such largely on the basis of radiological evidence. A critical analysis of this evidence shows that it bristles with difficulties and controversy. It is evident that the accuracy of such a diagnosis is of great clinical importance in assessing the natural history of diverticulosis and in formulating policies of management.

I do not intend to review the history of this condition. There are many excellent reviews of this aspect in the literature, and the reader is referred to the paper of Todd[3] as an example.

Incidence

It is difficult to establish the exact incidence of diverticulosis, and more especially the frequency with which diverticulitis complicates it. An often quoted statement is that 5 - 10% of people over the age of 40 have diverticulosis of the colon, that 20% of these will develop diverticulitis, and that 20% of those with diverticulitis, i.e. 4% of patients with diverticulosis, will require some form of surgery.[2,3] Boyden's[13] estimate is a half of the above figures. In a valuable review of 503 patients with diverticulosis seen in office practice, and followed for periods of up to 18 years, Horner[19] found that 85, or 16%, developed evidence of diverticulitis, and that only 2 of these, i.e. 0·4% of all his cases of diverticulosis, required surgery. His thesis is therefore the benign character of the natural history of this condition.

The incidence of diverticulosis among the general population can be calculated either from barium-enema studies or from autopsy material. Morton[4] found diverticulosis in 6·5% of 8,500 autopsies, and Ochsner and Bargen[5] reported diverticula in 7% of a series of autopsies at the Mayo Clinic. Pemberton et al.[6] found diverticulosis in 8·5% of 47,000 barium enemata at the Mayo Clinic. A similar figure (8%) was found by Grout[7] in 2,179 consecutive barium enemata.

Age incidence. The greatest incidence undoubtedly occurs in the later decades. Of Smithwick's[8] cases, 87% occurred in the 5th, 6th and 7th decades, while 95% of Bacon's[9] patients were over 40. In 2,000 consecutive barium enemata at the Massachusetts General Hospital, Welch et al.[2] found no cases under the age of 35. After 35 there was a steady increase with age, until two-thirds of all barium enemata at the age of 85 showed diverticula. The importance of this very high incidence in the aged patient becomes apparent when the aetiology and management of the group with massive rectal haemorrhage is considered.

Lloyd-Davies[1] and other authors drew attention to the great difficulty in accurately estimating the incidence of diverticulitis supervening on diverticulosis. We shall consider this problem in greater detail at a later stage.

Sex incidence. There are conflicting reports on the sex incidence in the literature. Edwards[10] and Lockhart-Mummery[11] found no sex difference in diverticulosis, whereas diverticulitis showed a male preponderance. Ford[12] and Welch et al.,[2] on the other hand, found the incidence of diverticulitis

in females to equal or exceed that in males. Boyden[13] found no sex difference.

There is a steady increase in deaths from diverticulitis. This is considered to be a manifestation both of the increasing age of the population,[14] and of better diagnosis.[1]

Anatomy and Pathogenesis

It is now generally accepted that diverticula of the large bowel, with the possible exception of those in the caecum, are acquired in origin. In a classical paper in 1916, Drummond[15] drew attention to the pattern of the vascular supply of the colon (Fig. 1). In the transverse and sigmoid colons, the vessels do not pierce the muscular coat of the
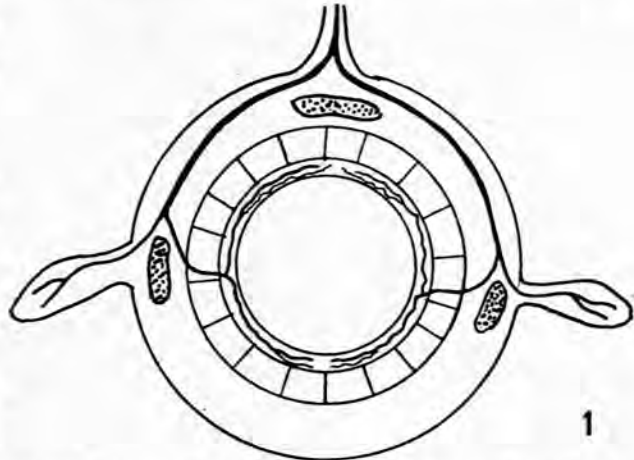

Fig. 1. Diagram of the pattern of blood supply to the colon (after Drummond).

bowel immediately on reaching it, but run circumferentially in the subserosa until the margin of the corresponding taenia is reached. At this point they dip inwards through the circular layer and then ramify in the submucosa. These penetrations form 'loci minoris resistentiae' through which pouches of mucous membrane herniate, and the diverticula are thus formed in 2 parallel rows situated between the mesenteric and the 2 antimesenteric taeniae. Once formed, the diverticula enlarge in the direction of least resistance, namely, into the appendices epiploicae or into the leaves of the mesentery. The appendices epiploicae are thus of no aetiological significance in the genesis of diverticula. Lloyd-Davies[1] records only one case in which the area between the antimesenteric taeniae was involved. According to Drummond then, the blood vessels of the normal colon predispose to sacculi to the same extent that the spermatic cord predisposes to inguinal herniation.

Granted the existence of potential weaknesses in the wall of the colon in all people, there must be some precipitating factor or factors to determine the appearance of actual mucosal herniations in some individuals only. In conformity with the development of herniae elsewhere in the body, this may be a factor in the wall converting a potential weakness into an actual one, or a factor producing a pathological increase in intraluminal tension.

That factors in the wall are important, is supported by the undoubted fact that the incidence rises with increasing age. Not all aged people develop diverticulosis, however, and some

patients affected are relatively young. Is there a basic connective-tissue defect, either congenital or acquired, in these patients? The association of hiatus hernia and diverticulosis is well known. Horner[19] found an incidence of 16·3% of hiatus hernia in 292 of his series submitted to barium-meal examination. It would be instructive to assess the incidence of direct inguinal hernia or weakness in patients with diverticulosis, but I am unaware of any such correlation having been attempted. Weakening of the wall of the bowel as a result of obesity has been implicated, because of a common clinical impression that patients with diverticulosis are usually obese. The present series, and several others in the literature[15,19] fail to confirm obesity as an aetiological factor in these patients. Stretching of the vascular apertures owing to chronic venous congestion has also been postulated as a causal factor. However, Drummond[15] found no cases of diverticulosis in a postmortem series of patients dying from chronic venous congestion.

Of factors producing a pathological increase in intraluminal tension, constipation is usually cited as being important. In the present series only about one-third of the patients complained of constipation, but an exact analysis is purposely not attempted, since 'constipation' is a notoriously elastic symptom, and a retrospective analysis from case notes would only magnify the error. However, Horner,[19] in his personal and prolonged follow-up, found constipation to be present in only 14% of his patients. Edwards[10] felt that incoordinated action of the bowel muscle is important because the vascular outlets become smaller during contraction and larger during relaxation of the gut wall, so that incoordinated action producing contraction of 2 segments with relaxation between them would bring about circumstances conducive to formation of mucosal herniation. Of significance in this respect is the finding[19] that 83% of 42 patients who were X-rayed several years before the appearance of diverticula were diagnosed as having the spastic-colon syndrome.

The racial difference in Johannesburg is also very significant. I reviewed all the barium enemata performed at the Coronation Hospital over a two-year period and was unable to find a single case of diverticulosis of the colon in an African. This is in accordance with the clinical experience that diverticulitis is an extreme rarity in the African. The cause of this is obscure, but it may be significant that the spastic-colon syndrome is very seldom such a source of therapeutic despair in the African patient as it is in the European. It has also been claimed, probably with tongue in cheek, but possibly with an element of truth, that diverticulosis is a social disease, being prevalent in communities which inhibit the passage of flatus.

It must be noted that not all authors accept the blood-vessel theory of the aetiology of diverticulosis. Fausler[16] stated that the areas of weakness are caused by degenerative changes in the muscle, while Henderson[17] felt that inflammatory episodes cause weakening of the wall and *precede* the appearance of diverticula.

HAEMORRHAGE

Bleeding per rectum is a relatively common accompaniment of diverticulosis and diverticulitis of the colon. The exact frequency with which diverticular disease of the colon is directly responsible for the bleeding is subject to much difference of opinion. In 1939 Rankin and Graham[18] stated that diverticula have little significance from the diagnostic point of view, and that further investigation and the passage of time will usually reveal the real cause. On the other hand, authors like Welch,[2] Smithwick,[8] Boyden,[13] Bacon and Sherman,[9] and Stone,[17,48] stated that bleeding is an important symptom, the incidence given ranging from 11·6%[13] to 80%.[9]

The bleeding is of 2 main types. On the one hand there is the massive exsanguinating haemorrhage, which is almost invariably associated with uncomplicated diverticulosis. A variant of this form is the patient who presents with a severe hypochromic anaemia without any obvious bleeding episode. This also appears to be a complication of diverticulosis rather than diverticulitis. On the other hand, mild bleeding tends to occur in association with diverticulitis, although uncomplicated diverticula do not necessarily bleed massively. Analysis of the present series confirms these 2 tendencies. The incidence of occult blood in the stools could not be determined in this series, since the investigation was not performed sufficiently often to draw any conclusions. The patients to be discussed therefore all had macroscopic bleeding.

Of the 90 patients in this series, 27 complained of passing blood per rectum. In view of the great frequency with which diverticula are an incidental finding, all patients with other lesions which may reasonably have been the cause of the bleeding, have to be excluded, and 5 of the 27 were so excluded. Two patients had hiatus hernia, 1 patient had a duodenal diverticulum as well, and 2 patients had obviously bleeding haemorrhoids. There are thus 22 patients left who had no other detectable source for the bleeding, an incidence of 25%. It is felt that this figure is too high because the cases were selected, all being hospitalized, and in such selected cases bleeding is obviously an important symptom. Bacon[9] claimed that it ranks equal in incidence with perforation, fistula formation and intestinal obstruction, and Welch et al.[2] used it as an indication for resection in 5% of their cases submitted to surgery. The overall incidence in this series was 27%.

Massive Haemorrhage

Fraenkel[20] quoted Corry in Oxford as teaching that when an elderly or middle-aged person, apparently in fair health, has a sudden, unexpected and alarmingly profuse recta

TABLE I. MASSIVE HAEMORRHAGE

Age	Sex	Clinical diagnosis	Barium enema	Barium meal	Treatment	Result
75	F	Diverticulosis	Diverticulosis	Normal	Conservative	Bleeding stopped
81	F	Diverticulosis	Diverticulosis	Normal	Conservative	Bleeding stopped
72	F	Diverticulosis	Diverticulosis	Normal	Conservative	Bleeding stopped
70	F	Diverticulosis	Diverticulosis	Normal	Conservative	Bleeding stopped
84	M	Diverticulosis	Diverticulosis	Normal	Conservative	Bleeding stopped
68	M	Diverticulitis	Diverticulitis, ? carcinoma	Normal	Resection	Bleeding stopped
83	F	Diverticulosis	Diverticulosis	Normal	Conservative	Bleeding stopped

haemorrhage of perhaps several pints, full investigation is likely to reveal diverticulosis of the colon only, and bleeding is unlikely to continue. A week or more later the stools will be clear of occult blood, which differs from what is found in carcinoma of the colon. Hoar and Bernhard[21] stated that carcinoma of the colon is undoubtedly the commonest cause of colonic bleeding, overt or occult. However, cancer of the colon is a relatively uncommon cause of massive exsanguinating rectal haemorrhage.

Of the 90 patients in this series, 7 (8%) presented with massive rectal haemorrhage (Table I). The advanced age of the group is immediately apparent, the range being 68 - 84 years, with an average of 79 years. There is a marked female preponderance in this group. In 6 of the 7 patients, the clinical and radiological picture was that of diverticulosis uncomplicated by any diverticulitis. The barium enema invariably showed extensive and massive diverticulosis (Fig. 2), an important feature when the surgical implications are considered. In 1 case only was the clinical and radiological

Fig. 2. Extensive, diffuse diverticulosis in a patient with massive rectal harmorrhage.

picture that of diverticulitis. This was also, incidentally, the youngest patient in the group (68 years) and he presented with a mass in the left iliac fossa. A barium enema showed a filling defect which could not be distinguished from a carcinoma, and he accordingly underwent resection. In all the other patients the treatment was conservative. All required vigorous resuscitative measures in the form of blood transfusions, which were massive on occasion. All the patients recovered on this management and there was no further bleeding while they were in hospital. In all cases barium-meal

examinations revealed no other cause for the haemorrhage.

This experience is in accordance with that reported in the literature. The vast majority of authors recommend a conservative approach. Hoar and Bernhard[21] are practically alone in their advocacy of a more aggressive attitude. They feel that the majority of these patients are very old and this age group withstands repeated major haemorrhages very poorly.

If the surgeon is forced to operate because of failure of conservative measures, and this does happen rarely, he is likely to be faced with a dilemma after the abdomen has been opened. A localized area of diverticulosis, and the absence of any other aetiological lesion, lends itself readily to surgery, but, as has been shown, the lesion is usually diffuse, and it is difficult or impossible to locate the bleeding site. The mucosal erosions may be too small to recognize even by inspection of the opened specimen at operation or autopsy.

To cope with this problem several procedures have been advocated, ranging from simple closure of the abdomen to sub-total colectomy.[49] Intermediate procedures are blind resection of the most involved portion of the colon, usually the sigmoid, or the performance of one or more localizing colostomies and subsequent resection of the half of the colon which is involved.[50] Kunath[51] has mentioned the instillation of topical coagulants (a mixture of powdered 'gelfoam', topical thrombin and neomycin) through a caecostomy. The isolation of serial segments of the colon, each 'milked' empty of blood, by means of non-crushing clamps, observing which segment refills with blood, and dealing with it, is a recent and ingenious suggestion.

It is evident from the reports quoted above that surgery for massive colonic haemorrhage from diverticulosis is beset with difficulties and dangers. This, coupled with the experience, which our own supports, that the vast majority settle on conservative measures, should make the surgeon extremely hesitant to operate on these patients. It goes without saying that gastro-duodenal bleeding, a not too uncommon cause of massive rectal haemorrhage, must be excluded, but I feel that the correct attitude is an even more conservative one than that of Kunath,[51] who suggested a therapeutic policy similar to that for upper gastro-intestinal bleeding. The pathology is different in the 2 groups. The cause of massive bleeding in diverticulosis can be deduced from a consideration of the anatomy and pathogenesis of the pouches. It is evident from Fig. 1 that a moderately sized artery is separated from the lumen of the colon merely by the mucosa of the neck of the diverticulum, so that pressure from an impacted faecolith can conceivably cause erosion of this vessel with ensuing brisk haemorrhage. Inflammation is minimal and we do not have to contend with the presence of digestive juices in the colon, as is the case in the stomach or duodenum. Cessation of bleeding can thus reasonably be anticipated. The rarity of severe bleeding in established diverticulitis can be explained by the protective cushion of oedema and inflammatory tissue between the vessel mentioned and the lumen of the gut.

It is fully realized that the indictment of diverticulosis as the cause of the bleeding in this group is open to criticism. Two-thirds of people over the age of 85 have diverticulosis, and patients in this group are almost invariably aged. Many surgeons can quote cases where prolonged follow-up has brought to light another lesion, such as an angioma, which was probably the cause of the bleeding after all, and it is evident that this diagnosis can only be made by a process

TABLE II. MILD BLEEDING

Age	Sex	Clinical diagnosis	Barium enema	Treatment	Result
74	F	Diverticulitis	Diverticulitis	Conservative	Recovered
57	F	Diverticulosis	Diverticulitis	Conservative	Recovered
68	F	Diverticulitis	Diverticulitis	Conservative	Recovered
62	F	Diverticulitis	Diverticulitis	Surgical	Recovered
87	M	Diverticulitis	Diverticulitis	Conservative	Recovered
65	F	Diverticulosis	Diverticulitis	Conservative	Recovered
73	F	Diverticulitis	Diverticulitis	Conservative	Recovered
72	F	Diverticulitis	Diverticulitis	Surgical	Recovered
55	M	Diverticulitis	Diverticulitis	Surgical	Recovered
62	F	Diverticulitis	Diverticulitis	Conservative	Recovered
61	F	Diverticulitis	Diverticulitis	Conservative	Recovered
51	F	Diverticulosis	Diverticulitis	Conservative	Recovered
51	F	Diverticulosis	Diverticulitis	Conservative	Recovered

of exclusion. However, these patients do form a fairly characteristic clinical group: the advanced age, the extensive diverticulosis, the almost invariable response to conservative measures, and the absence of any other demonstrable cause.

Severe Hypochromic Anaemia without Overt Bleeding

Two patients presented with severe hypochromic anaemia (haemoglobin $6 \cdot 5$ and $7 \cdot 6$ G. per 100 ml. respectively). Both were aged 80 years, and both had extensive diverticulosis on barium enema. Occult blood was present in the stools, and proctoscopy, sigmoidoscopy and barium-meal examinations revealed no other cause for the loss of blood. Both responded well to conservative measures. It is suggested that they fall into the same general category as the previous group.

Mild Bleeding

Of the 90 patients, 13 (15%) gave histories of mild rectal bleeding. Data concerning them are summarized in Table II and provide an interesting comparison with that of the group which bled massively. They are younger than the first group, the average age being 66 years as compared with 79 years. The clinical presentation was that of diverticulitis in 9 patients, while in only 4 was there no clinical evidence of inflammation of the colon. The barium-enema report was that of diverticulitis in all the cases, but, as will be discussed later, the clinical side is probably more important. Three patients were treated surgically, but in none of them was the bleeding the immediate reason for surgery.

(To be continued)