small numbers of segments by Taylor, Petter, and Whittenberger (1955), using the same methods of presentation.

These losses are somewhat less than those described by Gaensler *et al.* (1953) after resection of one or two segments. They also fail to show any striking excess of loss of oxygen uptake over ventilation, a finding which the work of Gaensler *et al.* (1953) prompted them to suggest that much of the loss of function following segmental resection was due not so much to decrease of functioning lung tissue as to post-operative haemothorax, parietal pleural fixation, and eventual fibrothorax. The figures presented here do not support this contention, and suggest that the great part of the loss of function is due to removal of lung tissue. It is felt that the careful technique (Thompson *et al.*, 1954) aimed at the early and complete re-expansion of the lung and the avoidance of the accumulation of any fluid in the chest is of the greatest importance in achieving this result.

It is apparent that the usual method of presenting the function of one lung as a percentage of the total function, while being useful in isolated studies, has in follow-up studies the disadvantage of obscuring changes that have taken place in the only lung which has been subjected to procedures likely to change the function. It is surprising that the method described here has not been used in previous reports on function following surgery. While the mathematics involved in bronchspirometry results are of the simplest, they are not always so regarded by those not familiar with them, and one is therefore reluctant to introduce a different method of presentation. However, the calculation of the change in function of the actual lung under consideration is not only a more useful but also a simpler and more easily understood concept. This enables (Table VII) the actual percentage loss of the lung per segment removed to be calculated. The results so obtained have been shown to be of a very reasonable order, particularly as in 63% of the cases the lung tissue was predominantly aerated and functioning.

The losses from segmental resection are similar to those reported for extrapleural pneumothorax (Gaensler and Strieder, 1950) and for five-rib thoracoplasty (Lindahl, 1954).

In this study the rather wide scatter of the results as indicated by the high standard deviation and range is a matter of some concern. Other reports do not include estimations of the standard deviation, but Taylor *et al.* (1955) give their range of values, and these appear to be much the same as those observed in the present study. Such scatter would appear to be inevitable in this type of biometric work.

Summary

From 62 cases of old pneumothorax studied, 16 (about 25%) were chosen as being "ideal" and the functional results analysed; 10 of these also had contralateral disease.

Twenty-seven cases with localized tuberculosis were studied before and after segmental resection. Physical signs, fluoroscopy, maximum breathing capacity, and differential lung function were investigated in the early post-operative period (8.7 weeks average).

In the "ideal" pneumothorax series the average loss of function was a little greater than that due to segmental resection.

In the segmental series the loss of function due to the disease was small, and in 63% of cases the segment was predominantly well aerated. The bronchographic appearances were closely related to these findings.

After operation there was often limitation of the movement of the diaphragm, but this almost invariably improved in later months.

The loss of function after resection was small. A method of expressing this as a percentage of the initial function of the operated lung is described and the per-

centage loss per segment is calculated. This demonstrates that the loss is of the order to be expected from the removal of the lung tissue alone.

The extent of the disease can almost invariably be accurately assessed by study of all previous radiographs, two-plane tomography, and bronchography.

Thanks are due to the patients whose willing co-operation has made this study possible and to the consultant staff of Sully Hospital for permission to investigate patients under their care. I thank Dr. L. R. West, who constructed the excellent equipment used and whose practical assistance has been invaluable.

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TOTAL COLECTOMY AND ILEO-RECTAL ANASTOMOSIS IN DIFFUSE ULCERATIVE COLITIS

BY

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In view of the increasing incidence of surgery in the treatment of ulcerative colitis it seems an appropriate time to record the results achieved by total excision of the colon and restoration of continuity by ileo-rectal anastomosis. The results reported in this paper are those of a consecutive series of 47 cases of the diffuse disease involving the colon and the rectum treated by this method since 1951. Before operation every patient had been under experienced medical treatment, and surgery was undertaken only because this had failed to arrest the progress of the disease. On some desperately ill patients operation was performed as an emergency life-saving measure.

The concept of the preservation of the rectum in all except the very rare case, so that a normal route of evacuation may be established, has been referred to previously (Aylett, 1954, 1955). It can only be justified if it can be shown that: (a) the procedure can be carried out with low mortality and low post-operative morbidity; (b) the large majority of the patients return to full health and full economic ability and that the number of bowel actions, increased as a result of the excision of the colon, interferes little if at all with their lives; (c) the inflammatory changes in the rectum resolve in most cases; and (d) should the disease persist or recur in the remaining rectum to an extent sufficient to endanger health an ileostomy can be established and the rectum removed without risk.

It is proposed that each of these questions shall be answered by reference to the series under review, because if they can be replied to satisfactorily the suggested method of treatment must surely be regarded as preferable to the routine total ablation of the whole of the large intestine and the formation of a permanent ileostomy without any attempt to restore the continuity of the intestinal tract. However great the improvement in modern ileostomy-bag design, such a stoma is a very real handicap to inflict upon a patient often entering the threshold of his or her full adult life, and, moreover, it is one that is not infrequently the source of both major and minor surgical complications.

Can Total Colectomy and Ileo-rectal Anastomosis be Carried Out with Low Mortality and Morbidity?

On setting out upon this procedure it seemed that a direct anastomosis of ileum to rectum after removal of the colon would be fraught with the danger of failure of union

FIG. 1.—Line drawing showing the "safety-valve" temporary ileostomy made in continuity a few inches from the end-to-end anastomosis of ileum and rectum.

or at least of leakage, with consequent pelvic cellulitis and fistula formation. The end of the rectum is friable, inflamed, and oedematous, so that if the anastomosis was to be subjected to any increased intraluminal pressure, such as might readily occur in the immediate post-operative period as a result of the development of a minor degree of ileus, the possibility of disruption of an uncertain suture line appeared to constitute a very real risk.

FIG. 2.—Photograph showing the position of the temporary ileostomy with a disposable ileostomy bag in position.

It was thought that this risk would be eliminated if a side-to-side anastomosis of ileum to rectum was carried out and if, after mobilization of the rectum by division of the upper thirds of its lateral ligaments and of its posterior attachments, its upper end was to be exteriorized on the anterior abdominal wall, preferably through the lowermost part of the

paramedian incision. A "safety-valve" would thus be formed through which gaseous and intestinal content would discharge if the intraluminal pressure became raised. Thereby the anastomotic line would be protected from the effects of any distension.

This method was therefore adopted, and in no case in which it was employed did any leakage occur from the line of anastomosis. The only case of leakage in the series was in a patient with lesser inflammatory changes in the rectum in whom, misguidedly, anastomosis without this safety-valve was considered safe. In spite of drainage down to the anastomotic site the patient developed a pelvic abscess and a faecal fistula. Although final recovery resulted, the fistula required full exploration and weeks of drainage to effect its ultimate closure.

More recently we have carried out an end-to-end anastomosis of the ileum to the rectum decompressing the line of suture by means of a temporary ileostomy made in continuity and established through a separate stab incision in the left iliac fossa (Figs. 1 and 2). It is, of course, essential in such cases to obliterate the gap existing between the ileostomy and the lateral abdominal wall to prevent the possibility of post-operative obstruction resulting from the insinuation of coils of small intestine into this hiatus. This method was adopted because the closure of the proctostomy had at times proved difficult, and in some cases several operations were required to effect a final closure. The temporary ileostomy, sited as it is some distance away from the anastomosis, is readily closed, and it seems that as this method protects the anastomotic line equally well it will be the operation of choice.

The second way of achieving operative safety is, in the severely or desperately ill case, to carry out the procedure in two stages. We believe that in such cases the essential requirement is the excision of the colon, and we consider that the formation of an ileostomy alone has no place in the emergency surgery of ulcerative colitis. Haemorrhage and grave toxæmia can continue, and disruption of the colon proceed, in spite of the presence of a defunctioning ileostomy. The excision of the colon, therefore, must be undertaken, but owing to the grave condition of these patients further operative time must not be expended in attempting an immediate restoration of continuity. Thus, as a routine in these cases, following the colectomy, the upper end of the rectum is exteriorized through the lower end of the paramedian incision and the terminal ileum through the same wound at a slightly higher level (Fig. 3). The union of the two exteriorized ends, which does not involve the opening of the general peritoneal cavity, is undertaken when the patient has recovered from the effects of his or her colitis.

FIG. 3.—Photograph showing completion of first stage of two-stage procedure. Ileum and upper end of rectum have been exteriorized through lower end of paramedian incision.

With these techniques and with the closest attention to post-operative care the mortality has been well under 5%, 2 of the 47 patients having died. In one the cause of death was obstruction following secondary suture of a burst abdomen. The second patient died from anuria. He was admitted with acute ulcerative colitis and an associated complete prostatic obstruction and uraemia. Whilst the bladder was being decompressed and the colitis treated with

cortisone perforation occurred. Emergency colectomy was undertaken, but anuria subsequently developed.

Post-operative morbidity has not been excessive. One patient had three episodes of obstruction—two due to adhesions and one to the volvulus of the small intestine—in the first post-operative month. Two patients developed intestinal obstruction two years after their operation, the result of band formation. Five operations were therefore undertaken for obstruction and all three patients recovered. In another patient secondary haemorrhage into the pelvis 10 days after operation necessitated reopening the abdomen for its control.

One patient who had had a side-to-side anastomosis of ileum and rectum, with the formation of a safety-valve proctostomy, developed a fulminating staphylococcal enteritis with associated heavy infection and disruption of the abdominal wall. As it seemed likely that the anastomosis might break down it was undone and the end of the ileum brought out through a separate incision in the left iliac fossa. The patient recovered with antibiotic therapy, and restoration of continuity will be undertaken subsequently.

In seven patients closure of the safety-valve proctostomy was not effected at the first attempt, and in one patient five operations were required for its final closure. The method of eliminating this difficulty has been referred to. A further patient referred to above, in whom a safety-valve was not included in the operation, developed a faecal fistula.

Mild perianal excoriation has been present in four cases, one of which was complicated by a minor fistula-in-ano, which after operation healed completely. All these cases have responded to local applications of ointment.

With the exception of one case in which a transient arthritis of the knee-joint occurred six months after operation and which could have been attributable to other causes apart from the colitis, no systemic complications have resulted.

Do the Majority of Patients Return to Good Health Without an Excessive Number of Bowel Actions?

In the assessment of this question in respect of the 45 live patients in this series, five have been excluded, as the final stages of their treatment have not yet been completed. Forty patients therefore remain for consideration. These have been divided into four categories as follows:

1. Those whose health has returned completely, who have regained or in some cases exceeded their normal weight, who are engaged fully in their former occupations, who enjoy a normal social life, and whose number of bowel actions do not exceed six in 24 hours. Many, as will be seen from the table, have a smaller number of evacuations.

Number of Bowel Actions Experienced by Patients in Category 1

No. of bowel actions in 24 hours	1	2	3	4	5	6
No. of patients	1	1	2	7	10	8

Isogel, and in some cases the occasional codeine tablet, is all that is required to control their bowels. Twenty-nine, or approximately 70%, of the cases in this series fall into this category (Fig. 4).

2. Those who are in good health, who have gained weight, who are back to work, but whose number of bowel actions, varying between 7 and 10 in 24 hours, limits slightly their full return to a normal life. Nevertheless in this category is included an engine-driver, a long-distance lorry-driver, and a foreman builder. Our experience has been that after about 12 months some in this category join those in category 1. At present there are six patients in this group, or 15% of the total.

3. Those who have returned to good general health but whose number of bowel actions is over 10. There are two female patients in this group, and both have weak sphincters. Each is 67 years of age. One suffered from complete prolapse of the rectum in addition to her colitis and prior to operation had not been outside her house for two years. The excessive number of bowel actions in this small group would undoubtedly seem to be associated with laxity of the sphincters, and the urgency with which the frequency is associated also suggests this. In the older female patient with patulous sphincters a permanent ileostomy may be preferable, but neither of the patients in this group would consider this step, as in spite of their disability they appear to manage reasonably well.

4. Those who at present have a residual proctitis producing symptoms. In this category are three patients, or approximately 8% of the series. Although two of these patients have been back to full work and the third, a girl, has been attending school with few absences, periodic anaemia has had to be treated. The two adult patients are now under treatment with intrarectal ultra-violet light, and the degree of subsidence of the inflammation in the rectal mucosa has so far been most pronounced.

Do the Inflammatory Changes in the Remaining Rectum Resolve in Most Cases?

We had noted, before undertaking ileo-rectal anastomosis, that in certain cases treated successfully by a medical regime the gross ulcerative changes visible on sigmoidoscopy subsided with apparent re-epithelization of the ulcerated areas. In such cases the resolution appeared to follow the control of the toxæmia associated with the disease and the return of the patient to normal health.

Biopsies from the rectum taken before and after a successful end to medical treatment confirmed our visual impression that the wall of the bowel had in fact become re-covered with epithelium. It was indeed true that the normal regimented pattern of mucosal glandular structure was not re-formed, but nevertheless the underlying partially fibrosed rectal wall did become covered with epithelium.

As a result of this observation it seemed reasonable to suppose that if in those cases

FIG. 4.—Pre- and post-operative photographs of a patient treated by the method described. Her bowel is opened once in each 24 hours. Pre-operative weight 5 st. 11 lb. (36.7 kg.), post-operative weight six months later 8 st. 9 lb. (54.9 kg.).

FIG. 5.—Pre-operative (a) and post-operative (b) rectal biopsies.

which were not responding to medical treatment the colon containing the vast bulk of the disease was to be excised, then the cause of the gross toxæmia would be removed and with the consequent return of the patient to good health the inflammatory changes in the residual rectum might well resolve.

If the toxæmia was to be overcome it seemed essential that the whole of the colon, including the pelvic colon, should be excised, as clinical and pathological examination of many specimens of the disease had shown that the distal regions were often the most heavily affected. Should a lesser excision be undertaken it appeared likely that ill-health associated with the presence of a segment of the pelvic colon might well continue in a considerable proportion of the cases, so that resolution of the inflammation would not take place. The whole of the colon was therefore excised in the cases in this series and ileo-rectal anastomosis carried out, and we believe that the resolution of the inflammation in the remaining rectum that has taken place in all but three of the patients is dependent upon this total excision.

All patients have been repeatedly examined in the follow-up department and have been examined by a narrow-bore proctoscope. The mucosa appears to have regenerated in all except the three cases referred to. As a result of fibrosis the rectum will not distend as will a normal rectum, which is the reason for the use of a proctoscope with a smaller lumen. The mucosa, too, appears fixed to the underlying structures and has not the mobility of the normal rectal lining.

To record this resolution of the inflammatory change we have in many of the cases taken a rectal biopsy before and after operation, and the healing suggested by macroscopic examination has been confirmed to have taken place by the pathological examination of these specimens (Fig. 5).

It is therefore established that, following total colectomy and ileo-rectal anastomosis, resolution of the residual inflam-

mation in the rectum can occur, but, as will be seen from the sections, the normal pattern of palisaded glandular formation is only partially regained.

Should the Disease Persist or Recur in the Remaining Rectum can the Latter be Removed and an Ileostomy Established Without Risk?

No case has been converted to a permanent ileostomy, as the indications for this have not arisen in the present series. It would seem, however, that the conversion would not present any great surgical problem.

Summary

A series of 47 cases of diffuse ulcerative colitis treated by total colectomy and ileo-rectal anastomosis is analysed.

It is concluded that the operation can be carried out with a low mortality rate and low post-operative morbidity, and that 70% of the patients return to a normal economic and social life and a further 15% have only minor limitations, the result of some frequency of bowel action.

It is suggested that the procedure described should be the primary method of choice in the surgery of diffuse ulcerative colitis.

[Since the completion of this article several months ago the residual rectal ulceration in the two cases treated by intra-cavitary ultra-violet light has resolved. These patients could now be included in the first category.]

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SIMPLIFIED RADIOACTIVE IODINE THERAPY

BY

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The treatment of thyrotoxicosis with radioactive iodine (^{131}I) is now an established procedure for the management of selected patients.

The long-term experience of one of the pioneer groups of American workers has been reported (Chapman and Maloof, 1955), and Myant (1956) has reviewed the results achieved throughout the world from 1942 to 1954. In this country the most extensive reported experience has been that of Blomfield, Jones, Macgregor, Miller, Wayne, and Weetch (1955), who reviewed results in the first 140 patients treated in Sheffield.

Varying techniques have been used to obtain consistent and satisfactory results. Some workers attempt to simulate partial thyroidectomy by achieving remission in as many patients as possible by a single treatment with the isotope (Blomfield, Jones, Macgregor, Miller, and Wayne, 1951; Freedberg, Kurland, Chamovitz, and Ureles, 1952; Fraser, Abbatt, and Stewart, 1954; Chapman and Maloof, 1955). Others give small and repeated doses of the isotope, preferring to treat the patient gradually and slowly, hoping thereby to minimize the likelihood of producing myxoedema (Williams, Towery, Jaffe, Rogers, and Tagnon, 1949).