The treatment of cancer of the rectum and recto-sigmoid has long been a controversial subject. In English speaking countries the controversy at the moment is concerned chiefly with the use that should be made of the recently revived sphincter-saving operations in the treatment of this disease.

The word "revived" is used advisedly because, as the historical surveys of Wangansteen (1943) and Bacon (1945) show, these operations are mostly not of recent invention but were devised many years ago. However after a brief period of popularity they fell into disfavour in Britain and America for two main reasons; firstly because they were found to be associated with special dangers from necrosis of bowel, leakage and infection; and secondly because doubts arose as to the adequacy of removal of the disease achieved by these often very limited excisions. After the publication in 1910 of Miles' epochal work stressing the importance of the lymphatic system in the dissemination of rectal cancer and the necessity in treatment for a wide ablation of tissues, including the anal sphincters and levator muscles, that might harbour involved lymphatics, most British and American surgeons became convinced that sphincteric preservation was incompatible with the requirements of radical surgery.

During the succeeding years moreover an increasing number were attracted to the actual technique of operation described by Miles, so that by the middle 1930's his combined abdomino-perineal excision, or some modification of it, had become the procedure of choice in most centres.

The first step towards the re-introduction of sphincter-saving operations lay in a further examination of the pathology of spread of rectal cancer, on which Miles' tenets had been based. An enormous amount of careful research on this subject by Dukes (1930, 1940), Westhues (1930, 1934), Wood & Wilkie (1933) and Gabriel, Dukes and Bussey (1935) among others, failed to confirm Miles' observations in several important respects. In particular it largely discounted the importance attached by him to spread in a lateral and downward direction. Indeed Westhues (1934) went so far as to state that lymphatic extension never occurs below the level of the primary growth in operable cases.

The significance of this work in regard to surgical treatment was quickly seen by Pannett (1935) who on the strength of it advocated resection of rectal carcinomata with preservation of the major part of the rectum below the growth and subsequent restoration of continuity by end to end

suture; he employed an abdominosacral technique. Rayner (1935), Devine (1937) and Horsley (1937) also turned their attention to the possibilities of resection by abdominal and abdomino-anal methods. But the majority of surgeons seemed strangely reluctant to incorporate these new pathological conceptions in their practise. Thus at a meeting of the Section of Proctology of the Royal Society of Medicine in 1935 (see Turner 1935) to discuss the use of conservative operations in the treatment of rectal cancer the general feeling was that while they probably had a place it must always be very small.

A report by Dixon (1939 & 1940) of a series of over 75 cases of rectosigmoid growths treated by abdominal resection with a mortality of only 10% was particularly influential in showing that the technical difficulties could be satisfactorily overcome. Then came the important papers of Wangansteen (1943 & 1945) and Bacon (1945) on abdominal and abdomino-anal resection respectively, following which interest in these operations has become generalized. It would be wrong however to imagine that acceptance of them is universal. Several authorities such as Rankin (1947) Lahey (1947), Gilchrist and David (1947) have, even

recently, confessed themselves as strongly opposed to these procedures which they still regard as less radical and more liable to be followed by recurrence than the abdomino-perineal excision of Miles.

At St. Mark's Hospital our approach to the problem of sphincter conservation has been distinctly cautious. Having by degrees reduced the operative mortality of combined excision to the vicinity of 10%, and having established the satisfactory fact that approximately 50% of the survivors of this operation were alive and well 5 years later, we were naturally reluctant to change to an alternative method which might be associated with greater immediate hazards or a lower ultimate survival rate. The fact that our patients were invariably left with a permanent colostomy did not weigh heavily in our minds against the combined operation, because we have never subscribed to the views of Pannett (1935, 1943), Wangansteen (1945), and Bacon (1945), according to whom the possession of a colostomy would seem in many instances to be a fate little better than death itself. They write of colostomy as usually being a grave disability, often producing chronic invalidism, and leading on occasions to divorce, suicide and even

attempted homicide of the offending surgeon! Obviously if this is the true state of affairs it justifies - nay demands - the avoidance of colostomy at almost any price in terms of operative mortality and recurrence.

Well, at St. Mark's Hospital we have had a very considerable experience of colostomy cases, and have no hesitation in describing these accounts as exaggerated. In our opinion these are the results not so much of colostomy as of colostomy followed by inadequate instruction in its management. We find, as Dukes (1946) has recently pointed out, that though the prospect of a colostomy is naturally repugnant to the average patient, when the operation has been performed and he has been taught how to look after himself, he is agreeably surprised to discover that the inconvenience resulting from his colonic stoma is very much less than he ever anticipated. Not only is life still worth living but a full and energetic life, in conformity with his years and general condition, is still possible. In very few cases indeed is the colostomy a serious disability.

Consequently we have never felt that we could advise the adoption of an operation solely on the grounds that it avoided a permanent colostomy.

For us, as for Allen (1946), the prime objective in operating for carcinoma of the rectum, as for all cancers, is the most thorough removal of the disease possible. The question of colostomy is entirely secondary. Unless therefore we could feel confident that sphincter-saving operations offered as great a prospect of cure as did an ordinary combined excision, and with no greater immediate risks, we were not prepared to employ them. Until recently we have not had this confidence, and the use of these operations in our hands was therefore confined to a very few cases with extremely early growths which we reckoned clinically were probably unassociated with lymphatic metastasis and could be satisfactorily dealt with by a more limited excision than usual.

About 12 months ago however a careful review of the question by Mr. C. Naunton Morgan, Mr. O. V. Lloyd-Davies and myself compelled us to modify our opinion and to accept tentatively the idea that, even in certain more advanced cases with lymphatic extension, a resection operation with subsequent restoration of continuity might be as radical as an orthodox combined excision. In accordance with this change of view resection procedures have been much more frequently employed

by us, and in the last 12 months we have performed 41 of these operations. Admittedly time alone will establish with certainty whether the cases so treated have in fact been afforded as good a chance of cure as if they had been subjected to combined excision. At this stage the decision must be based essentially on pathological evidence and this therefore demands the closest attention.

It is the purpose of this thesis to examine this evidence, and also to consider the anatomical and technical factors governing the use of restorative resections, so as to determine the place that they may legitimately assume during this interim period in the treatment of rectal and rectosigmoid cancer.

The Spread of Carcinoma of the Rectum and Rectosigmoid.

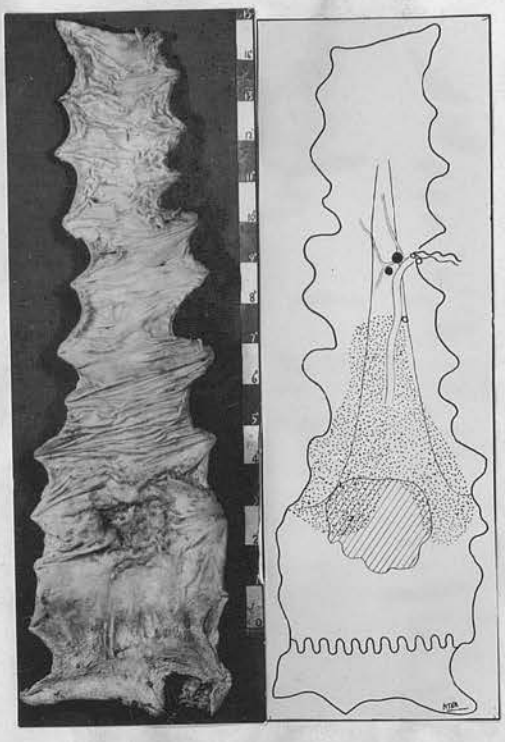
The logical foundation of any operation for cancer must be an understanding of the manner in which the disease spreads in the body. The modes of extension of carcinoma of the rectum and rectosigmoid, as seen from the surgical point of view, will therefore be briefly considered. The literature on the subject is voluminous for, with the possible exception of carcinoma of the breast, no

malignant tumour has been subjected to such close pathological study. Unfortunately the information is to some extent contradictory; and in an effort to clarify debatable points a special analysis has been undertaken of the pathological records made on a series of 1500 operative specimens of rectal and rectosigmoid carcinomata in the Cancer Research Department of St. Mark's Hospital. The specimens were all obtained by combined excision - i.e. synchronous combined excision (Lloyd-Davies 1939), perineo-abdominal excision (Gabriel 1932, 1945) or abdomino-perineal excision (Miles 1926, 1939) - and were prepared, dissected, photographed, drawn and documentated in the manner described by Dukes (1940). They represent practically all the combined excision material received in the Department, from both hospital and outside sources, during the years 1937 to 1947 inclusive.

Direct Spread.

Direct spread of a rectal carcinoma occurs in two planes, one circumferentially and longitudinally in the substance of the bowel wall, the other radially through it. The former increases the area of the growth as seen from the mucous aspect; it is fairly accurately represented by the surface extent of the lesion. The suggestion of Sampson

Handley (1910) that it is a more insidious and widespread process associated with permeation of the submucous lymphatic plexus to a distance of as much as 5 or 6 inches beyond the manifest margin of the growth was not confirmed by Cheatle (1914), Monsarrat and Williams (1913), Cole (1913) and Miles (1926), who concluded that such microscopic spread was very limited. Westhues (1930, 1934) as a result of observations in 74 specimens stated that direct spread into the rectal wall beyond the apparent edge of the neoplasm never extended more than 1.5 cms. distally, 2 cms. proximally or 3 cms. laterally. So far as the removal of the primary growth in the rectal wall was concerned therefore he considered that it would be sufficient to secure a margin of clearance of 1 to 1½" on the proximal and distal sides of the lesion. Though we have occasionally seen carcinoma cells in the submucosa a considerable distance beyond the primary growth, more or less as described by Handley, this has only been in very malignant anaplastic growths. Such cases have been so excessively rare and their prognosis so uniformly bad that we have no hesitation in saying that this extensive local spread is of no practical significance. In general the findings in our own series of specimens are in



PRIMARY GROWTH

GLANDULAR METASTASES

UNAFFECTED GLANDS

INTRAVASCULAR GROWTH

OTHER TISSUES INFILTRATED WITH CARCINOMA

Fig. 1.. Photograph and drawing of combined excision specimen of carcinoma recti showing very extensive upward extra-rectal spread.

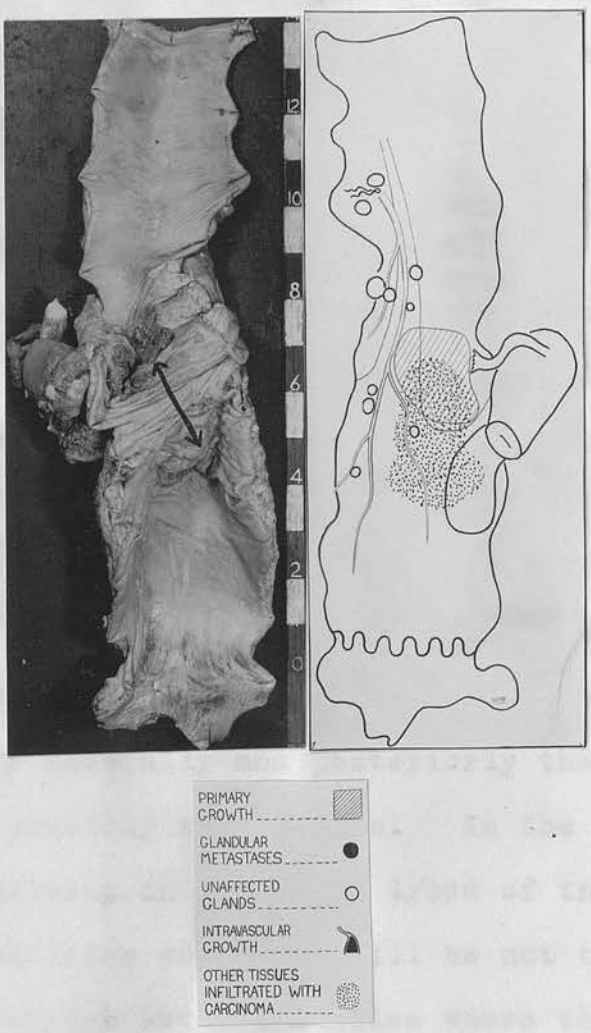


Fig. 2. Photograph and drawing of combined excision specimen of rectal carcinoma with adherent uterus and uterine tube, showing marked downward extra-rectal spread.

agreement with Westhues' observations.

With regard to spread through the rectal wall, in 85% of operation specimens according to Dukes (1940) the growth has completely penetrated the wall and come to involve the perirectal tissues. When this stage is reached extensive extra-rectal spread may occur not only in the horizontal plane but also proximally and distally beyond the limits of the growth in the bowel wall itself (see Figs. 1 & 2). Also fixation to adjoining parts may develop; this is due not always, or indeed usually, to malignant invasion but often to an inflammatory reaction round about the tumour as has been emphasized by Goligher (1941). Such adhesions will involve anteriorly the related viscera, - small gut, uterus, vagina, prostate or seminal vesicles - and laterally and posteriorly the parietes and possibly the ureters. In the case of a growth arising in the lower 1/3rd of the rectum, the parietes concerned will be not the bony pelvis but the levator muscles where they form the pelvic diaphragm. In the series of 1500 specimens there were 28 in which the levators were implicated by growths in the lowest 2" of rectum in this way. The desirability of excising these muscles in low lying adherent growths is thus evident.

For this reason such growths would have been less radically treated by a restorative resection in which the muscles of the pelvic diaphragm are preserved than they were by combined excision in which the levators were excised in part.

But with carcinomata in the upper 2/3rds of the rectum and in the rectosigmoid it seemed from our specimens that however extensive the adhesions to neighbouring structures or the amount of extra-rectal spread, removal of the primary growth itself could generally have been accomplished just as effectively by a relatively restricted sleeve resection as by the combined excision that was employed to secure the specimen. After all fixation to the sacrum or side wall of the pelvis can only be dealt with by separation which is done in an identical manner in the two operations. Similarly adhesions to other organs, requiring separation or concomitant resection could presumably be disposed of just as effectively during a rectal resection as a combined excision. Extra-rectal spread could likewise be equally thoroughly removed during a resection provided that care was taken to carry the line of section through the rectum and surrounding tissues fully 1-1½" beyond the palpable margin of the main tumour mass.

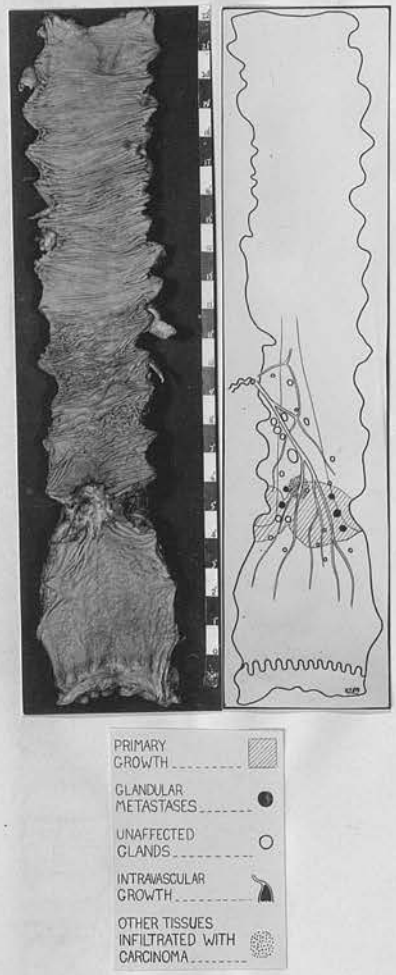


Fig. 3. Photograph and drawing of combined excision specimen of rectal carcinoma showing metastases in the anorectal lymph glands.

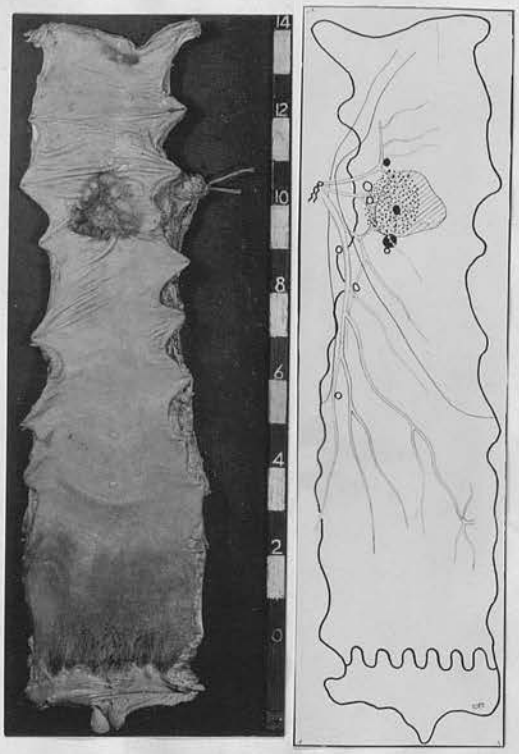


Fig. 4. Photograph and drawing of combined excision specimen of carcinoma of the rectosigmoid with involvement of the paracolic glands.

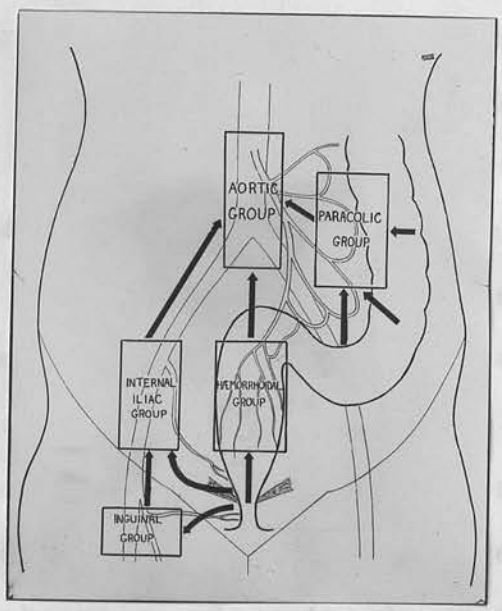


Fig. 5. Diagram to indicate the possible paths of lymphatic extension of carcinoma recti according to Miles.

Lymphatic Spread.

In 50% of the cases of rectal and rectosigmoid cancer treated by excision lymphatic metastases are already present (Dukes 1940), and it is the effort to deal with these that chiefly determines the shape of any radical operation.

The first lymph glands to be involved in rectal carcinoma are the anorectal or pararectal glands of Gerota in the immediate vicinity of the growth (see Fig. 3). These lie along the main branches of the superior haemorrhoidal vessels on the posterior wall of the rectum between it and its fascia propria. (In the case of a rectosigmoid or lower sigmoid carcinoma it is the corresponding paracolic glands lying in relation to the terminal arcades of the sigmoid vessels that are initially implicated - see Fig. 4). From here spread may theoretically take place along the lymphatic channels accompanying each of the 3 main sets of blood vessels to the rectum, the superior, middle and inferior haemorrhoidals (see Fig. 5). Miles (1910, 1920, 1926) described these 3 pathways as constituting the upward, lateral and downward zones of lymphatic extension respectively. He believed that spread occurred along all 3 in the majority of cases, but subsequent workers are unanimous in emphasizing that the 3 zones are not nearly of equal

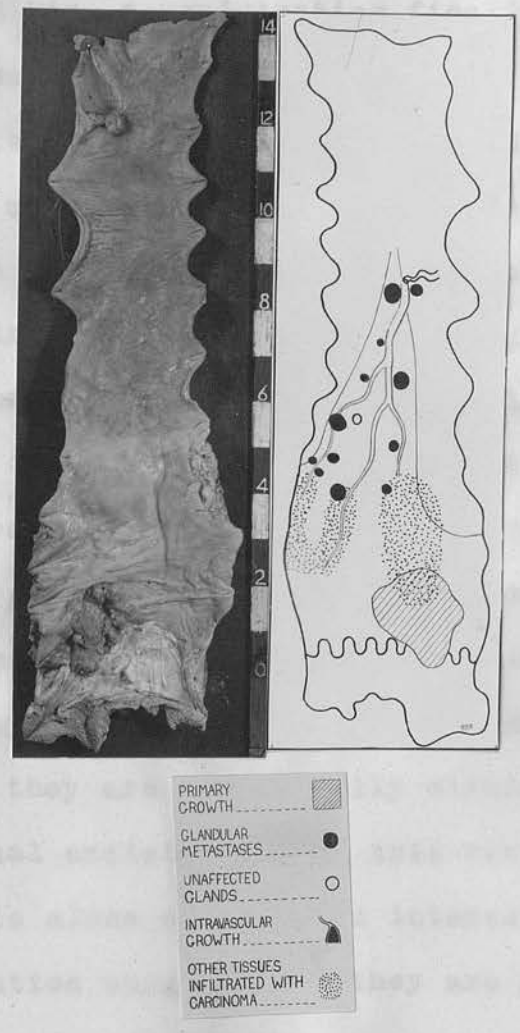


Fig. 6. Photograph and drawing of combined excision specimen of carcinoma recti showing numerous secondary deposits in the chain of glands lying alongside the superior haemorrhoidal and inferior mesenteric vessels.

importance, and that by far the most favoured is the upward one. Whatever the situation of the growth, however low in the rectum it may be, the glands along the superior haemorrhoidal and inferior mesenteric vessels may be extensively involved as shown in Fig. 6, culminating finally in spread to the aortic glands.

According to Miles (1920, 1926) moreover spread in this upward zone gave rise to deposits not only in these main glands but also in the left common iliac glands and in the paracolic glands in the pelvic mesocolon close to the bowel. It was because of involvement of these latter that he considered wide removal of the pelvic colon and mesocolon essential in any operation for rectal carcinoma. We have no accurate data as to the frequency of implication of the common iliac glands because they are not normally within the scope of a surgical excision. For this very reason the matter is alone of academic interest, but findings at operation suggest that they are seldom, if ever, the seat of metastases.

The question of the <u>paracolic glands</u> however is of paramount importance, particularly in regard to restorative resections, because in performing

any of these operations a considerable length of sigmoid colon with related mesocolon and contained paracolic glands must of necessity be retained for bridging the gap resulting from removal of the carcinomatous segment. Wood and Wilkie (1933) were unable to confirm Miles' statement, the paracolic glands being uninvolved in all their cases, and Gabriel, Dukes and Bussey (1935) could demonstrate deposits in these glands in only one of their hundred specimens, this being a case with an advanced rather high growth. In the series of 1500 specimens the paracolic glands contained metastases in only 30 or 2.00%. Without exception these cases were examples of rectosigmoid or lower sigmoid carcinomata rather than true rectal growths, and the paracolic glands involved were those in the immediate vicinity of the primary growth (see Fig.4). Obviously these glands would be removed in the course of excision of the affected portion of colon and mesocolon in accordance with the established principles of intestinal and mesenteric resection for carcinoma. In no case of rectal carcinoma proper, even when the superior haemorrhoidal and inferior mesenteric glands were extensively invaded, were deposits ever found in the paracolic glands.

It can be categorically stated then that spread in the upward zone from carcinoma recti is strictly confined to the glands alongside the main vascular stem in the base of the pelvic mesocolon, and that what should be removed in this region in a radical operation is this basal portion of the mesocolon with its contained vessels and glands to as high a level as possible. In a rectosigmoid or lower sigmoid growth the lowest part of the colon and mesocolon containing the last one or two sigmoid branches must also be sacrificed. The major part of the sigmoid colon and mesocolon can thus safely be preserved even with growths of the rectosigmoid.

Turning now to the lateral and downward zones of lymphatic spread, the glands receiving the lymph finally in these two zones are the internal iliac glands on the side wall of the pelvis and the glands of the groin respectively, and if carcinoma recti were to spread frequently by these routes we should expect these glands often to be the seat of secondaries. Well, the inguinal glands are eminently available for careful palpation and clinical observation, and we know that though commonly involved by epithelioma of the anal region they are never implicated in a case of adenocarcinoma of

the rectum unless it has grown down and invaded the skin of the anal canal. With regard to the internal iliac glands we have no precise information as to how often metastases occur in them because they are not included in our operation specimens, and, as with the left common iliac glands, we are dependant for our knowledge on surgeons' impressions at laparotomy. By the same token however the question of their involvement is of no practical significance; the general opinion, for what it is worth, is that they are seldom enlarged at operation.

Miles (1920, 1926) in his writings also figured a large number of intermediate glands in the course of the middle and inferior haemorrhoidal lymphatics - incidentally far more than are featured in the anatomical texts of Gray (1946), Cunningham (1943) & Poirier, Cuneo and Delamere (1903). It was to remove these, which according to him were frequent sites of metastases, as well as any permeation of growth in the lymph vessels themselves, particularly the plexuses lying on the levator muscles, in the anal sphincters and across the ischio-rectal fossae, that he advocated the invariable excision of all these structures. With the notable exception of Gilchrist and David (1938,

1947) subsequent workers such as Dukes (1930, 1940), Westhues (1930, 1934), Wood and Wilkie (1933), Gabriel, Dukes and Bussey (1935) have failed to demonstrate these glands, involved or uninvolved, and in not one of our 1500 specimens were we able to discover any of them.

As for secondaries in the levator muscles, anal sphincters and ischio-rectal fat, due to lymphatic permeation, routine palpation supplemented by macroscopic and microscopic section where required has failed to provide any unequivocal evidence of extension of the growth by this means into these structures. With low lying lesions, as already mentioned, involvement of these parts has occasionally been observed, but this we believe is rather a manifestation of direct spread than of lymphatic dissemination. With growths at a higher level, not actually in contact with the levators or sphincters, where any communication would presumably be by the lymphatic system, we have never found any of these secondary deposits.

Further evidence against such downward lymphatic spread is provided by the observations of Westhues (1934) that the pararectal glands below the level of the growth almost invariably remain free of growth. Dukes (1930), Wood and Wilkie (1933),

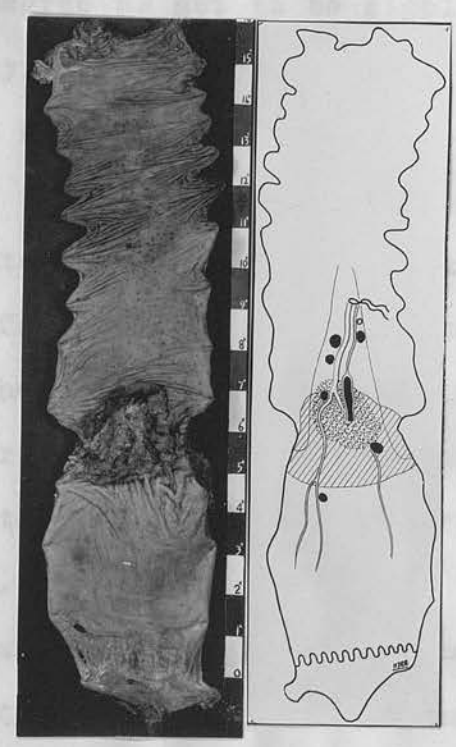


Fig. 7. Photograph and drawing of combined excision specimen of carcinoma of rectum showing glandular involvement extending for a short distance below the level of the primary growth.

and Gabriel, Dukes and Bussey (1935) agree that downward spread is only likely to occur when the upward route is heavily blocked by metastases. Glover and Waugh (1946) found downward involvement of glands more frequently but usually to such a limited degree as not to be significant in regard to surgery. However, Gilchrist and David (1938, 1947) who have been the most persistent upholders of Miles' teaching in its entirety, were able to demonstrate secondaries in the pararectal glands, often as far as 5.0 cms. below the growth, in 4.6% of their cases, and they felt that retrograde spread certainly could not be ignored in planning surgical treatment. With this view Colp (1938) concurred.

In our series of 1500 specimens 98 or 6.53% had metastatic involvement of glands below the level of the growth. This might at first sight appear to support the contention of Gilchrist and David (1938, 1947), but two further comments are relevant. In 68 of these cases the glands concerned lay within ½" of the lower margin of the growth as in Fig. 7; they would have been completely removed by a resection with division of the rectum and terminal branches of the superior haemorrhoidal vessels 1" below the growth. In the remaining 30 or

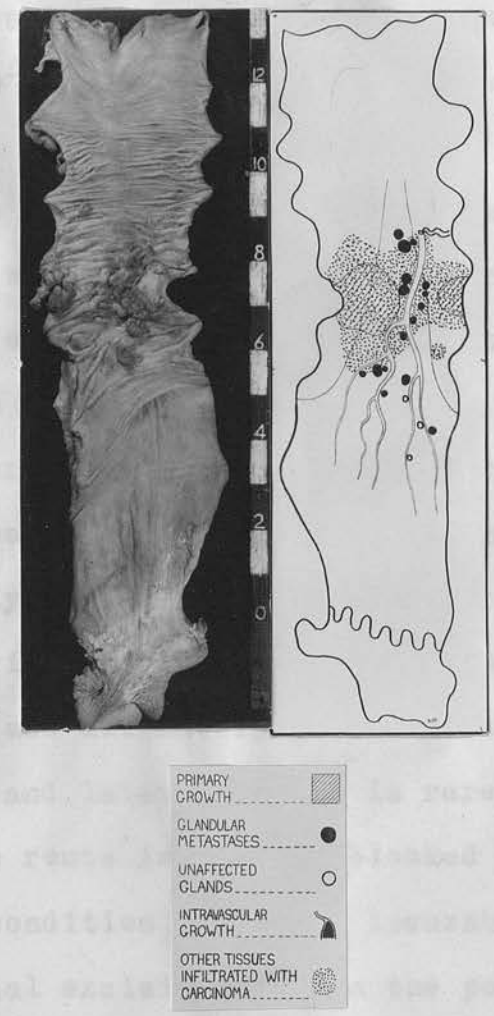


Fig.8. Photograph and drawing of specimen of carcinoma recti removed by combined excision, showing more extensive retrograde lymphatic spread. Note that all the glands in the upward zone of lymphatic extension are blocked with metastases.

2.00% where the extent of downward spread placed them outside the scope of a resection of this type as shown in Fig. 8, there were usually widespread metastases in the glands of the upward zone of extension as well. Obviously these rendered the prospects of cure by any operation extremely remote, and it is interesting to record that only 3 of these patients with marked retrograde spread treated by combined excision have lived more than 2 years and none have survived for 5 years.

We are entitled to conclude from this survey that spread by the lymphatic system is overwhelmingly by the upward route to the glands along the superior haemorrhoidal and inferior mesenteric vessels, and ultimately to the aortic glands. Downward and lateral spread is rare and occurs only when this route is heavily blocked by metastases and the condition is really incurable by any form of surgical excision. From the point of view of treatment therefore it would seem that there is little to be gained from the adoption of operations designed - somewhat ineffectively - to deal with spread in a lateral or downward direction.

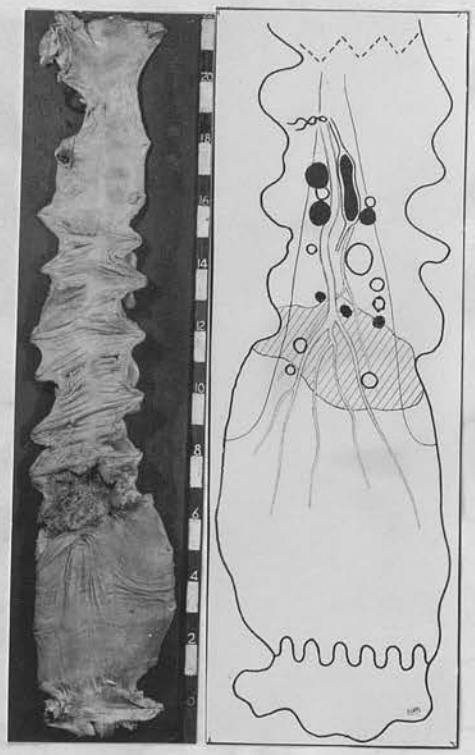


Fig. 9. Photograph and drawing of combined excision specimen of carcinoma recti in which marked upward spread has taken place in the lumen of the superior haemorrhoidal vein.

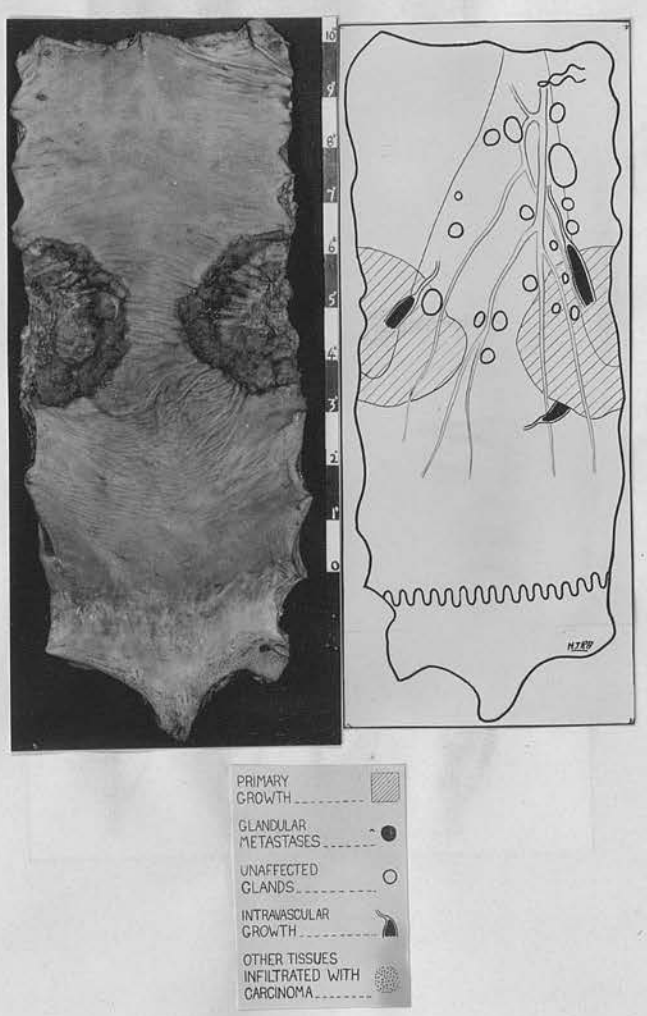


Fig. 10. Photograph and drawing of combined excision specimen of rectal carcinoma showing upward and slight downward venous spread.

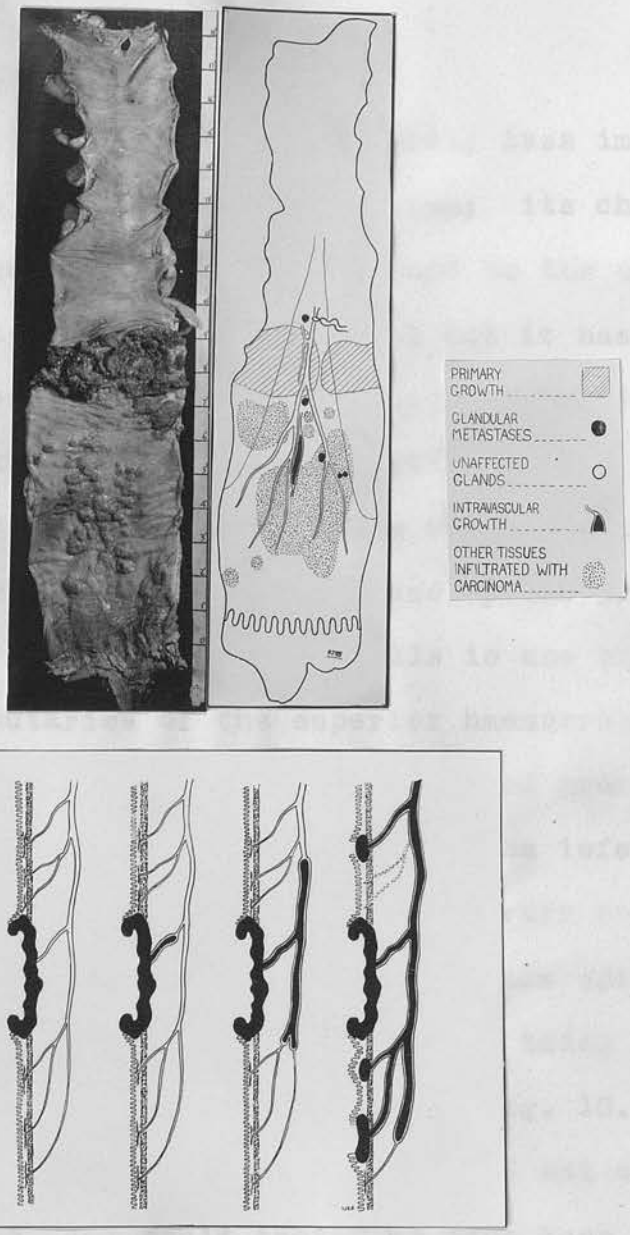


Fig. 11. Photograph and drawing of combined excision specimen of rectal carcinoma showing very extensive retrograde venous spread producing eruptions of growth on the mucous surface of the rectum below the primary ulcer. Diagram indicates the way in which these eruptions were probably produced.

Venous Spread.

Venous spread is perhaps hardly less important than spread by the lymphatic system; its chief significance is of course in regard to the ultimate development of hepatic metastases but it has also a bearing on the amount of tissue that should be removed with the tumour at operation.

Spread by the venous system was shown in approximately 18% of our specimens by the presence of a solid cord of malignant cells in one or more of the tributaries of the superior haemorrhoidal vein. Almost invariably this extended proximally, sometimes as far as the ligature on the inferior mesenteric vessels (see Fig. 9), but very rarely - in 14 or 0.90% of the cases - retrograde spread also occurred, intravenous permeation then being present below the level of the growth as in Fig. 10.
In 10 of these the downward spread did not extend more than ¼", and would therefore have been adequately removed by a resection operation which provided a 1" margin of clearance below. But in 4 specimens it reached to 2" or 3" below the growth and in 3 of these had caused eruption of growth on the rectal mucosa 2 or 3" below the main carcinomatous ulcer, as shown in Fig. 11. These cases would obviously not have been radically treated by

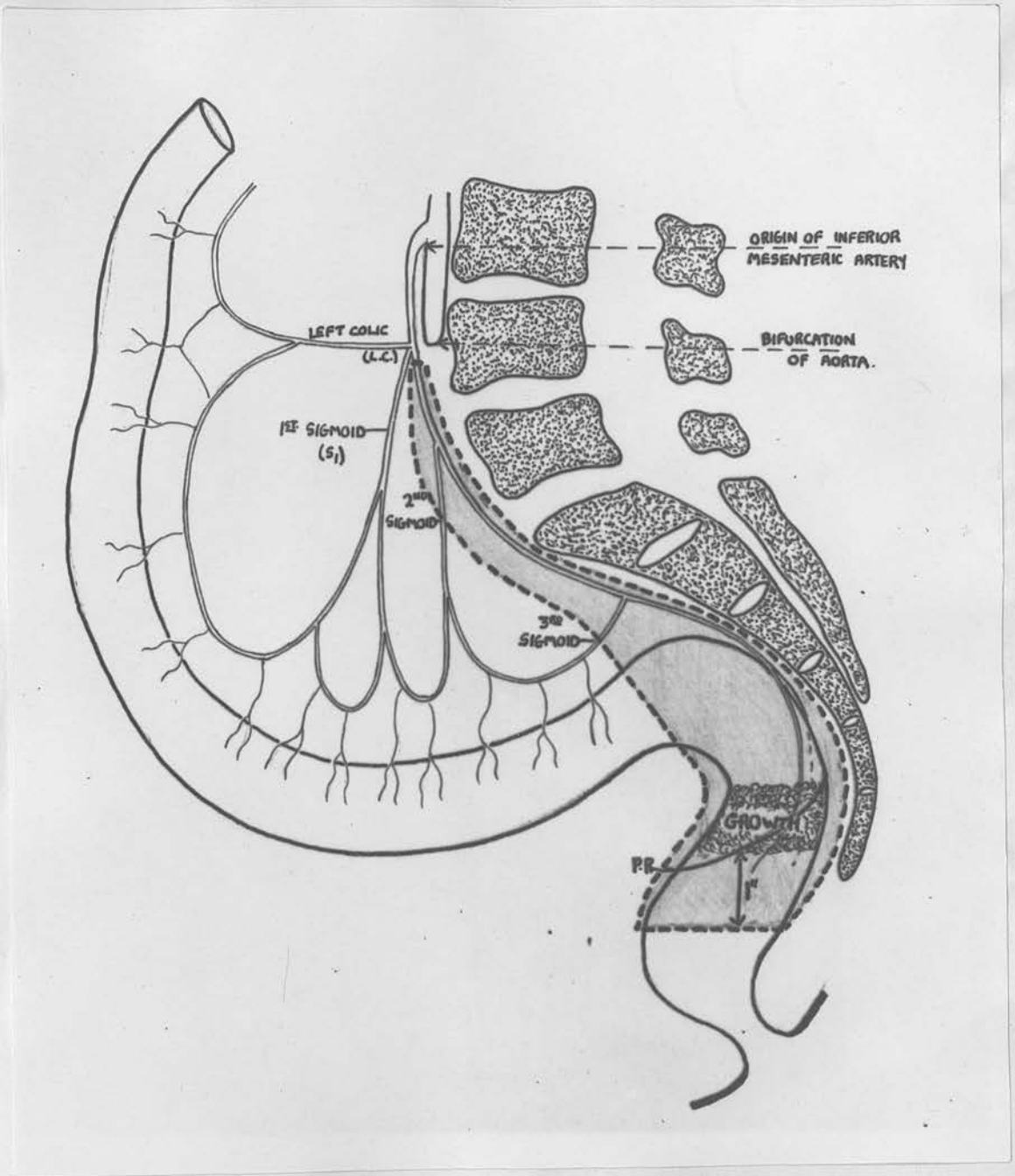


Fig. 12. Tissues requiring removal in radical operation for carcinoma in upper 2/3rds of rectum. Shaded area = tissues to be excised.

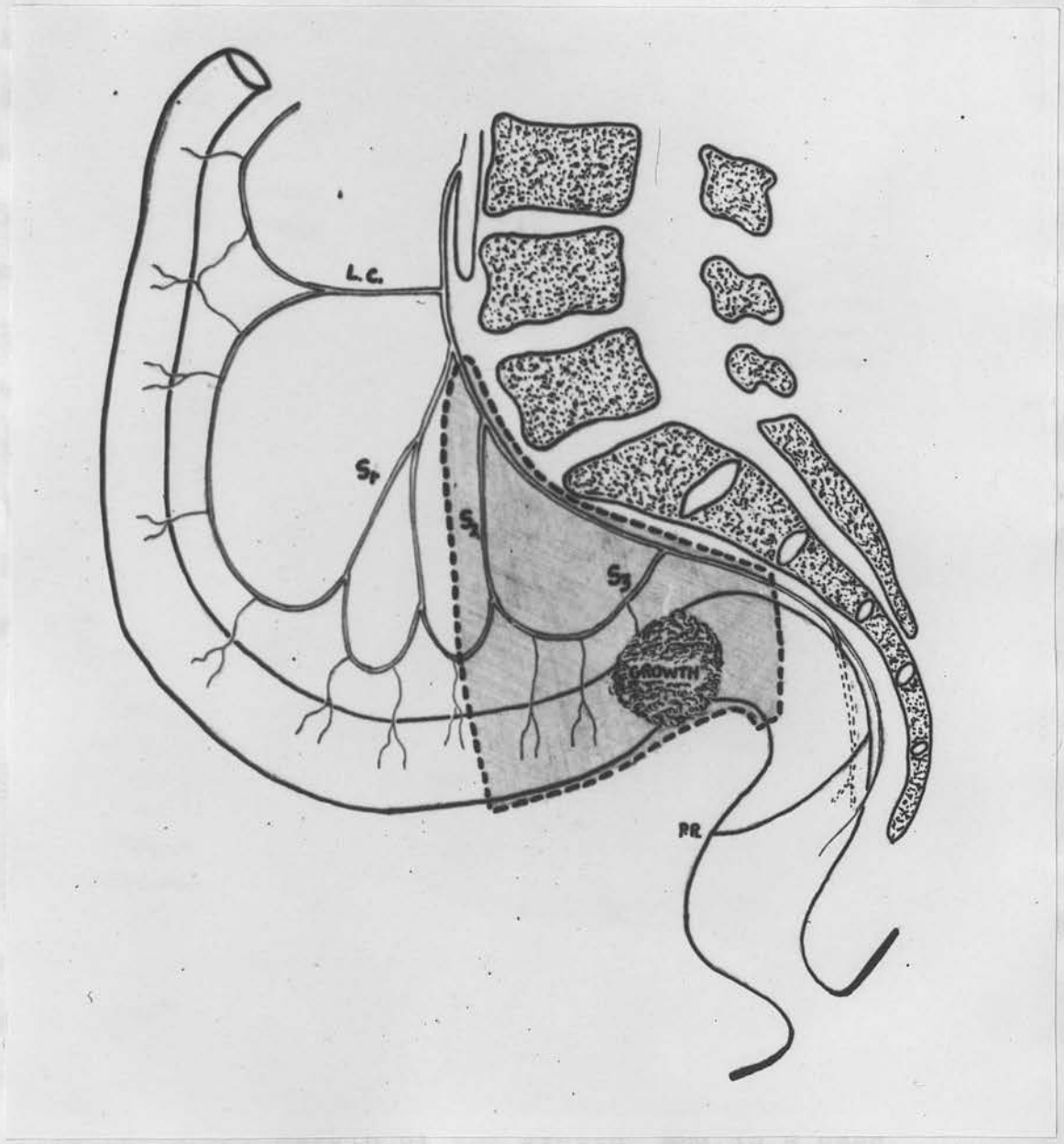


Fig. 13. Tissues requiring removal in radical operation for carcinoma of rectosigmoid or lower sigmoid. Shaded area = tissues to be excised.

the usual type of resection operation. It should be understood however that this extensive retrograde venous spread only occurred in very advanced growths with much lymphatic and venous spread in other directions, so that the prognosis would be poor whatever operation were employed. As a matter of fact none of them have survived more than 16 months after combined excision. In addition, as the nodules of growth which were present in the mucosa below the main carcinoma in 3 of the cases were appreciable clinically, these 3 cases would never have been selected for a resection procedure.

The Amount of Tissue that should be removed in a Radical Operation for Rectal or Rectosigmoid Cancer.

Figs. 12 & 13 indicate in general the extent of tissue that must be sacrificed in order to deal radically with carcinoma in this situation. It will be noted that inferiorly the line of section through the bowel, vessels and lymphatics runs 1" below the lower margin of the growth, and in a case with gross extrarectal spread this line will be related to it rather than to the growth in the bowel wall. Superiorly the tissues to be removed take the form of a long narrow cone lying

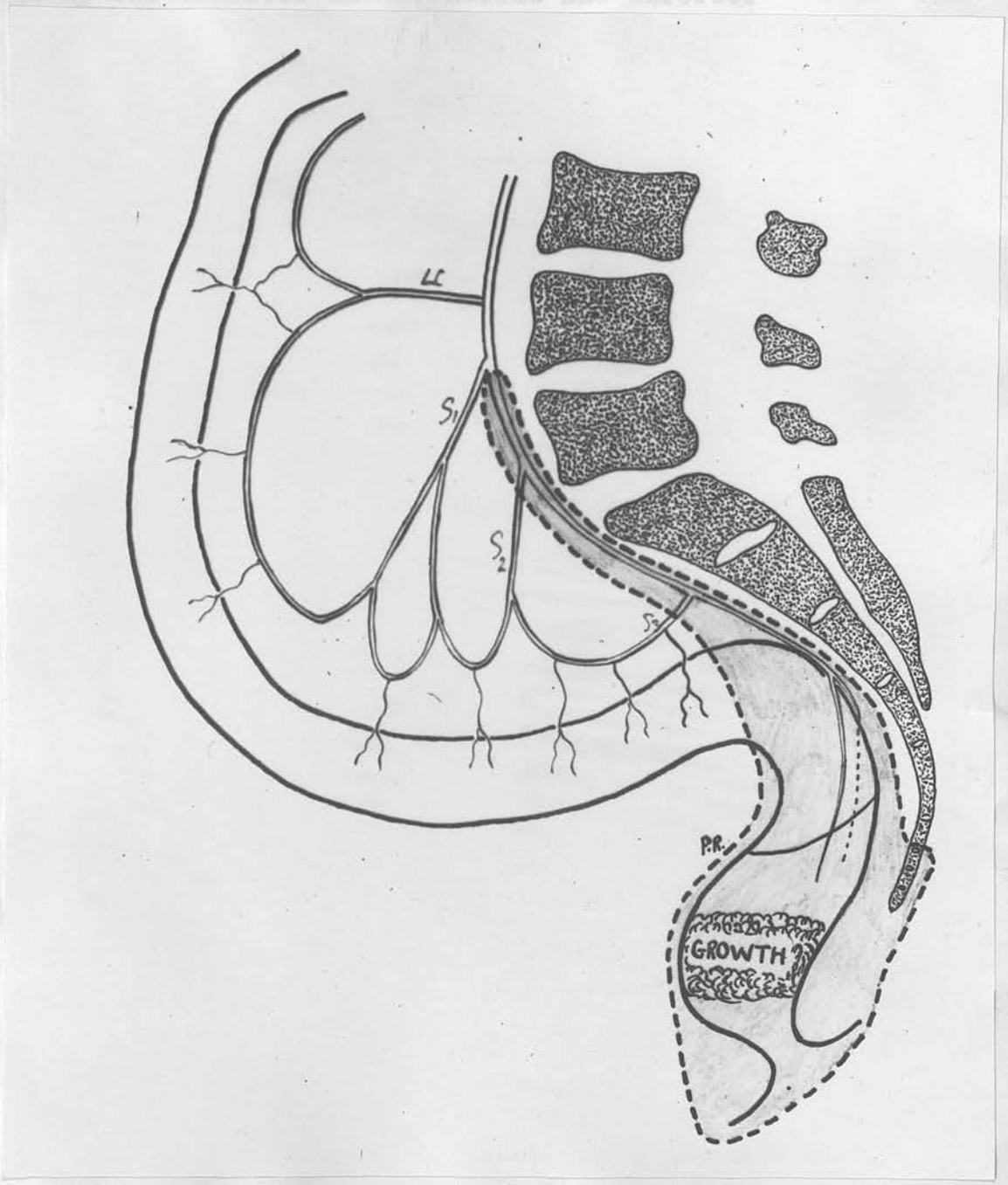


Fig. 14. Tissues requiring removal in radical operation for carcinoma in lower 1/3rd of rectum or anal canal. Shaded area = tissues to be excised.

along the superior haemorrhoidal and inferior mesenteric vessels with its base including a variable amount of rectum and sigmoid colon and its apex reaching high up on the main vascular stem - preferably as far as the origin of the first sigmoid branch. It will be appreciated also that part or the whole of an adherent related viscus such as the uterus or small intestine may occasionally require to be resected along with the rectum. In addition if the growth arises in the anal canal or in the lower part of the rectum with a margin of clearance of less than 1" between it and the ano-rectal ring it will be necessary to sacrifice the sphincter apparatus as in Fig. 14. Indeed because of the risk of direct spread from adherent growths in the lowest 1/3rd of the rectum into the related levator muscles it will certainly be unwise to attempt preservation of the sphincters and levators with any carcinoma the lower edge of which comes within 2" of the anorectal ring.

The Proportion of Cases Suitable for Resection Restoration of Continuity.

It will be seen from Figs. 12 & 13 that for carcinomata in the upper 2/3rds of the rectum or the rectosigmoid it is justifiable on pathological

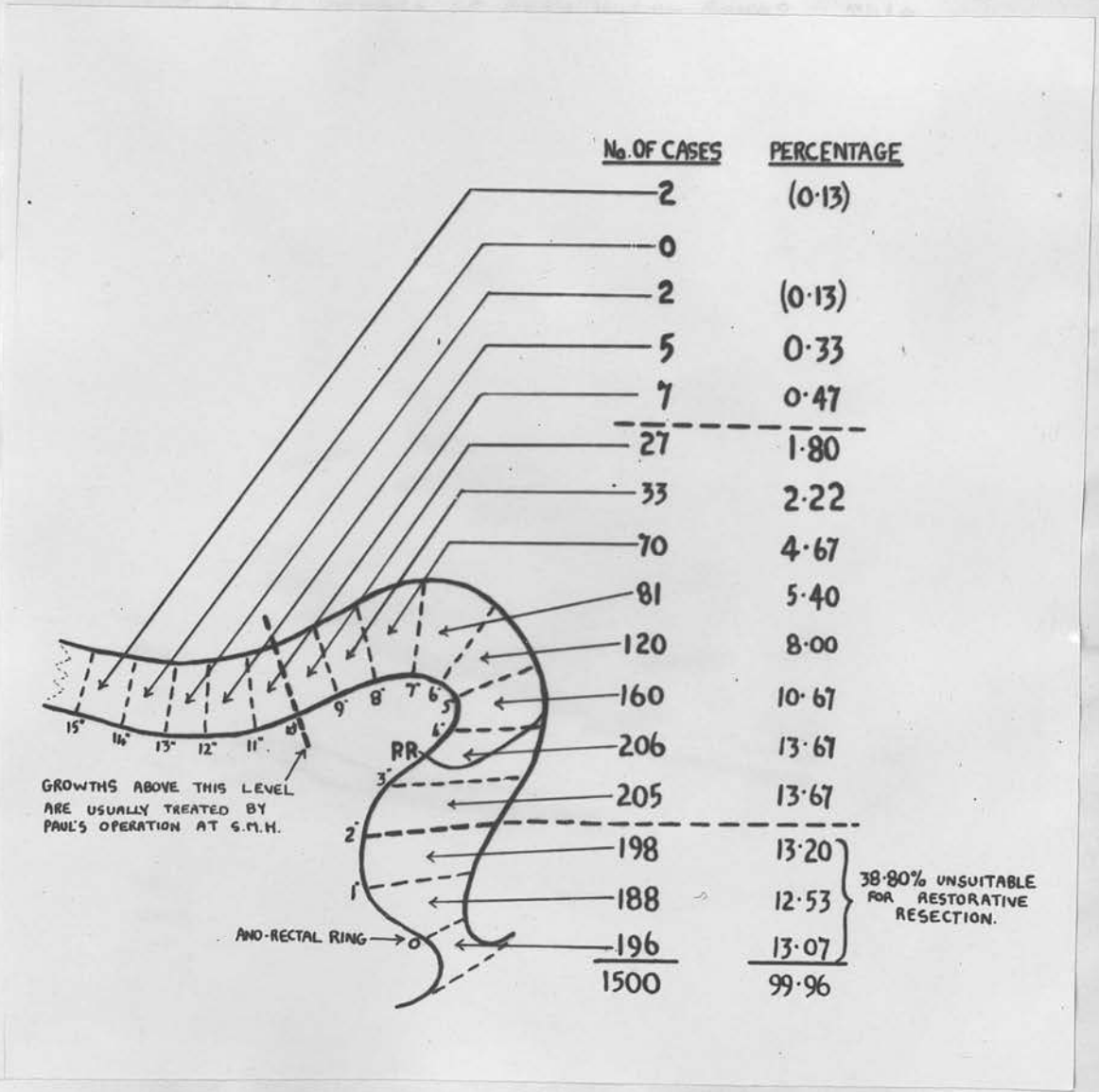


Fig. 15. Distribution of carcinomata in 1500 combined excision specimens. In cases where more than one carcinoma was present only the lowermost one was counted.

grounds to employ a resection operation which preserves an anorectal stump below, including the anal sphincters. What percentage of growths are so situated as to permit of this being done? This has been determined in respect of our series of 1500 combined excision specimens and the results are recorded in Fig. 15, regarding which certain comments should be made.

It must be emphasized first that the distances noted between anus and growth in these specimens are not identical with the measurements that would be made on the same cases during life by the sigmoidoscope. In the body the rectum presents several flexures; the sigmoidoscope does not follow these but takes a direct course from anus to growth and thus estimates this distance as less than it is found to be on the flattened stretched operative specimen, the discrepancy naturally being greater the higher the growth in the bowel. With a carcinoma in the upper 1/3rd of the rectum the difference is commonly of the order of 1½ to 2".

The peritoneal reflection off the front of the rectum is much used at laparotomy as a guide to the site of growths in the rectum and rectosigmoid. Its average position in the 1500 specimens has

therefore been calculated and found to be approximately 4½" from the anus, the extremes being 1½" and 8". No significant difference was noted in the two sexes. It will be observed then that growths may extend 1½" below the peritoneal reflection in the average case and yet be suitable for resection with preservation of the sphincters.

Finally it is not claimed that the distribution of growths revealed in Fig. 15 necessarily holds for other hospitals than St. Mark's. In a special institution of this kind dealing solely with rectal conditions probably an unduly large number of low rectal growths is seen; whilst in a general hospital a higher percentage of carcinomata in the rectosigmoid region, producing less typically rectal symptoms, may be encountered with a consequent alteration in the distribution. Certainly the figures recorded by Rankin, Bargen and Buie (1932) and Bacon (1945) show a greater proportion of upper rectal and lower sigmoid growths than in our series. Fig. 15 merely enables us to say that in approximately 60% of the cases of rectal and rectosigmoid cancer normally subjected to combined excision in our practise, the growth lay 2" or more above the anorectal ring

and could have been treated equally satisfactorily from the pathological point of view if the anal canal and lower rectum had not been sacrificed. In this proportion of our cases then adequate removal of tissue in accordance with Figs. 12 & 13 would have been compatible with the preservation of an anorectal stump below and a sigmoid stump above. The question of approximating these two parts and restoring continuity naturally arises. Just how often would it have been possible to have done this? Though technical factors have also to be considered the answer to this question depends primarily on the length of sigmoid stump that can be made available, with a good blood supply, to bring down to the rectum. This leads us to a consideration of the vascular arrangements of the distal colon and rectum, because it is by proper manipulation of these that the maximum portion of colon can be provided.

The Preparation of the Colon Stump.

The classical accounts of the blood supply to the rectum and colon given by Manasse (1907), Sudeck (1908), Archibald (1908), Drummond (1913), Pope and Judd (1929) and Steward and Rankin (1933) and a more recent contribution by Sunderland (1942) were consulted but were not found to be of much assistance in determining the lengths of colon likely to be available after ligation at different levels. The distribution of the inferior mesenteric artery has therefore been investigated with particular reference to this point in 75 fresh post mortem specimens obtained from adult cadavers coming to the necropsy room at St. Mary's Hospital. The method employed was to divide the peritoneal adhesions on the outer side of the iliac colon as in the early stages of an abdomino-perineal excision and to mobilise the whole sigmoid loop with its mesocolon by sweeping them medially so that they finally came to occupy a median anteroposterior plane. The arrangement of the vessels was then observed from the left side and the relationship of the bowel and the vessels to important landmarks, such as the bifurcation of the abdominal aorta, the promontory of the sacrum,

the peritoneal reflection and the tip of the coccyx, carefully noted. The colon and rectum from the level of the highest point on the left iliac crest above to a point at least 2" beneath the anterior peritoneal reflection off the rectum below were then removed and pinned out on a cork examination square in exactly the same manner as that in which they lay in the body after mobilisation. The vessels were then dissected so as to make their course clear but in some cases with very little fat in the mesocolon this was scarcely necessary. The specimen was finally drawn, and with the aid of the notes already made the various anatomical landmarks in the environment from which it had been removed were inserted in the sketch. The preparation was kept in a fresh condition throughout, fixation being avoided so as not to interfere with the natural length and elasticity of the bowel and vessels. The technique adopted by most previous workers of injecting the arteries with radio-opaque material and subsequently preparing radiographs of the arterial tree was tried in a few cases. Though it afforded a much better picture of the fine terminal arteries it was not found to have any special advantages in our particular

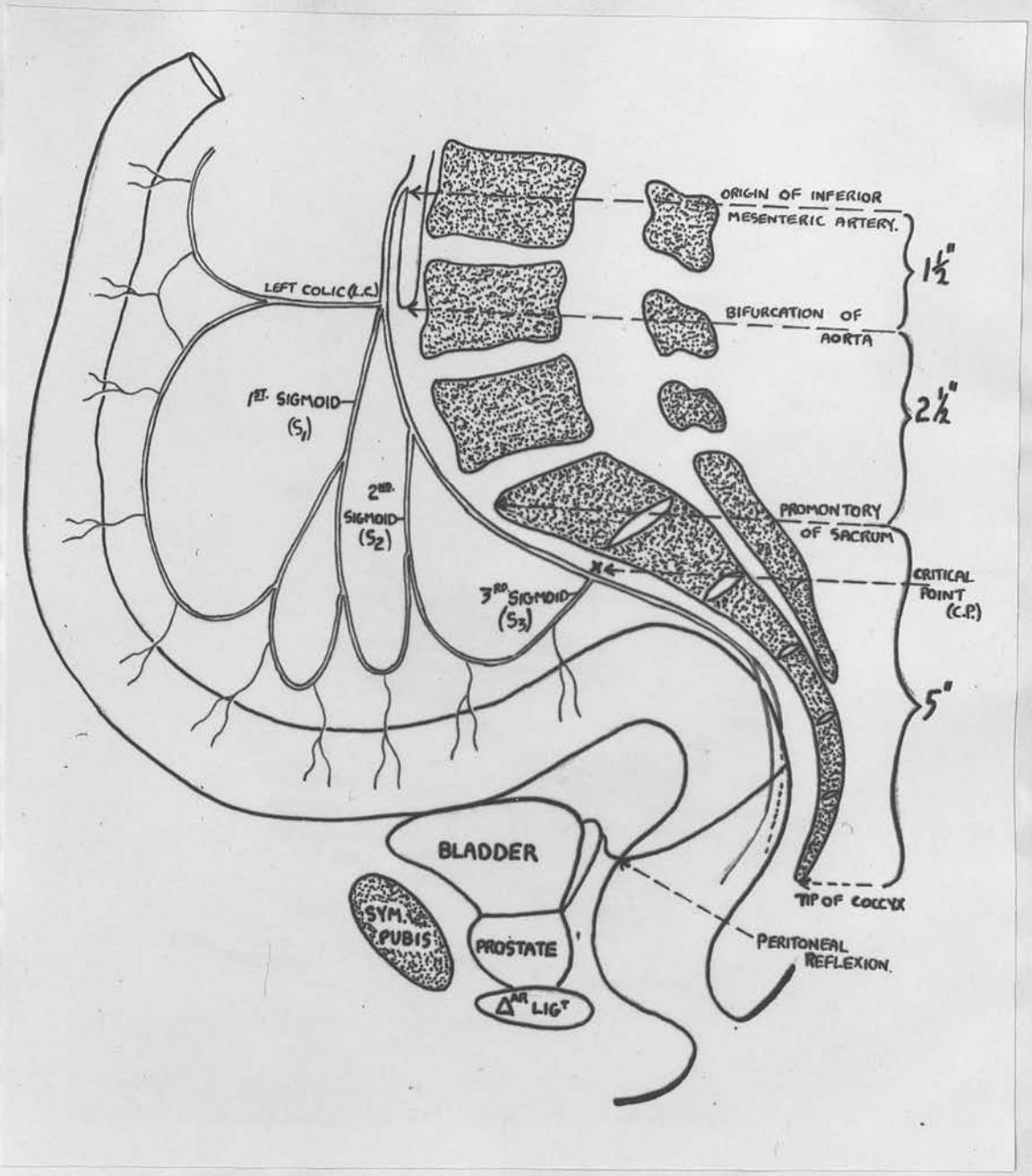


Fig. 16. Composite diagram representing the arrangement of the inferior mesenteric and superior haemorrhoidal arteries and their branches in approximately 60% of 75 necropsy room bodies. Special care has been taken to relate the arterial tree and bowel accurately to the bony pelvis and lumbar spine.

research in which the main interest lay in the larger vessels. With us its use was associated with certain administrative difficulties and it was therefore abandoned.

Fig. 16 is a composite diagram showing the average arrangement of the vessels and surrounding parts in 45 (or 60%) of the 75 specimens. It corresponds closely with the findings of Drummond in the majority of his preparations. It will be noted that the left colic (LC) and first sigmoid (S_1) branches arise conjointly from the main inferior mesenteric stem opposite the bifurcation of the abdominal aorta. In the remaining 30 specimens these 2 vessels are separated at their origin by a gap of between $\frac{1}{2}$" and $1\frac{1}{4}$", usually $\frac{3}{4}$", as in Fig.14. The number of sigmoid branches is not constant, there generally being 3, as shown in Fig. 16, but anything from 2 to 5 may be present on occasions. The lowest sigmoid branch is small, being distributed to the rectosigmoid and usually failing to anastomose with any of the ramifications of the main branches of the superior haemorrhoidal. The consequence is that there is no marginal artery in the rectosigmoid region comparable to that formed by the arcades between the other sigmoid branches, its place being here taken by the lowest sigmoid artery and superior

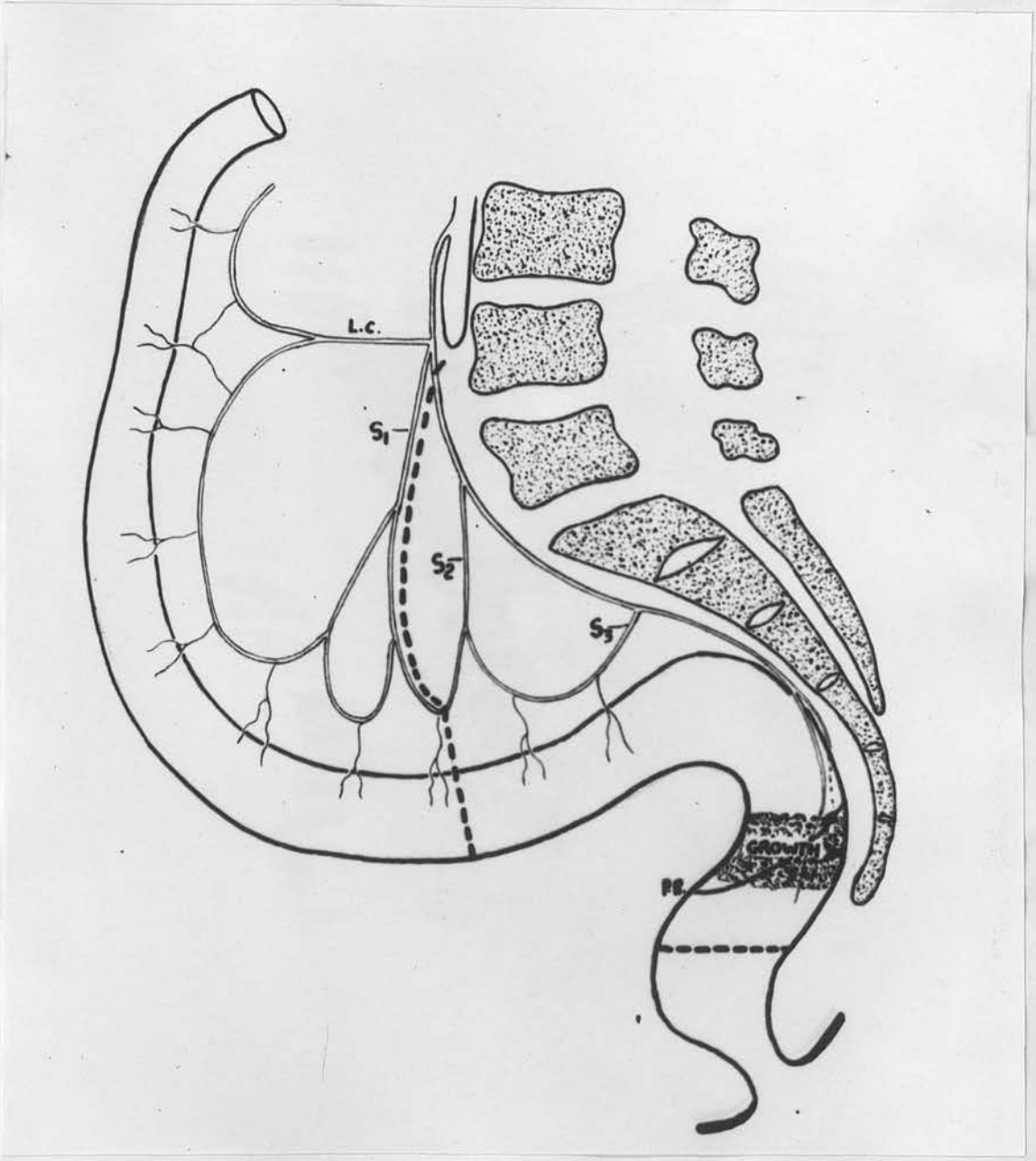


Fig. 17. Diagram showing the simplest method of preparing the sigmoid stump for restoration of continuity with the rectal remnant after resection. A direct blood supply to the end of the stump is provided by the first sigmoid artery (S_1).

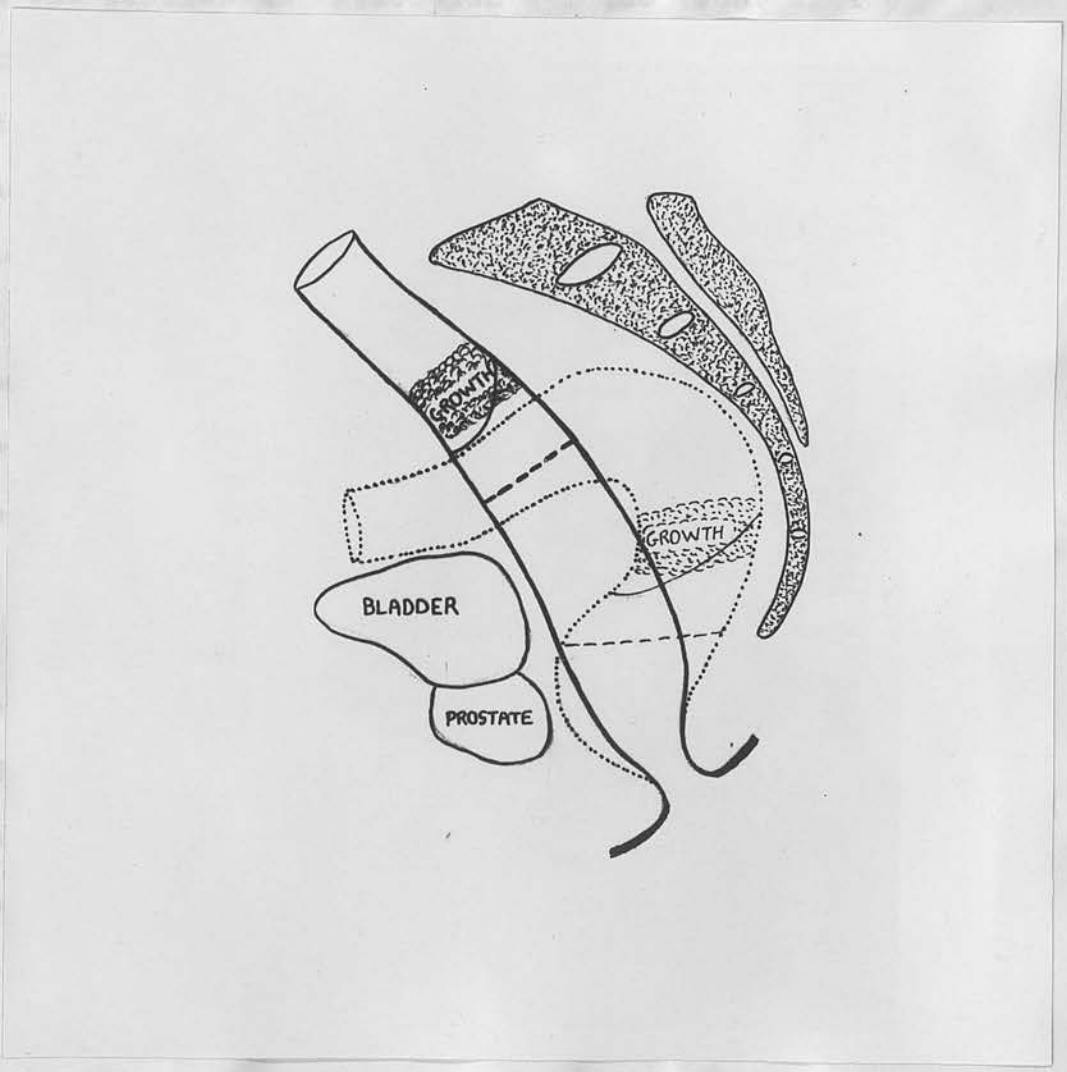


Fig. 18. Diagram to show how a growth in the middle third may be elevated 1½ or 2" in the pelvis when the rectum is mobilised and lifted out of the hollow of the sacrum.

haemorrhoidal trunk as pointed out by Sudeck (1908).

In the average case with a reasonable length of sigmoid colon, the most dependent point on the loop is some distance from its lower end, and, lying on the bladder, as in Fig. 16, is almost on a level with the peritoneal reflection off the front of the rectum. Generally this piece of colon is supplied by S_1, so that by tying the inferior mesenteric vessels just below the origin of this branch and dividing the mesocolon parallel to it as shown in Fig. 17, a sigmoid stump is obtained, which extends almost to the peritoneal reflection, with a direct blood supply to its tip. For any growth the lower edge of which lies 1" to 1½" above the reflection this portion of colon will therefore usually suffice for bridging the gap resulting from resection. For some at a lower level it will also be adequate because, as Wangansteen (1945) has emphasized, when the rectum is mobilised so that it assumes a straight course upwards from the anus instead of lying in the concavity of the sacrum, the level of the peritoneal reflection may rise as much as 2" (see Fig. 18). A growth that originally lay with its lower edge at the level of the peritoneum might thus after mobilisation be capable of being resected with a one inch margin

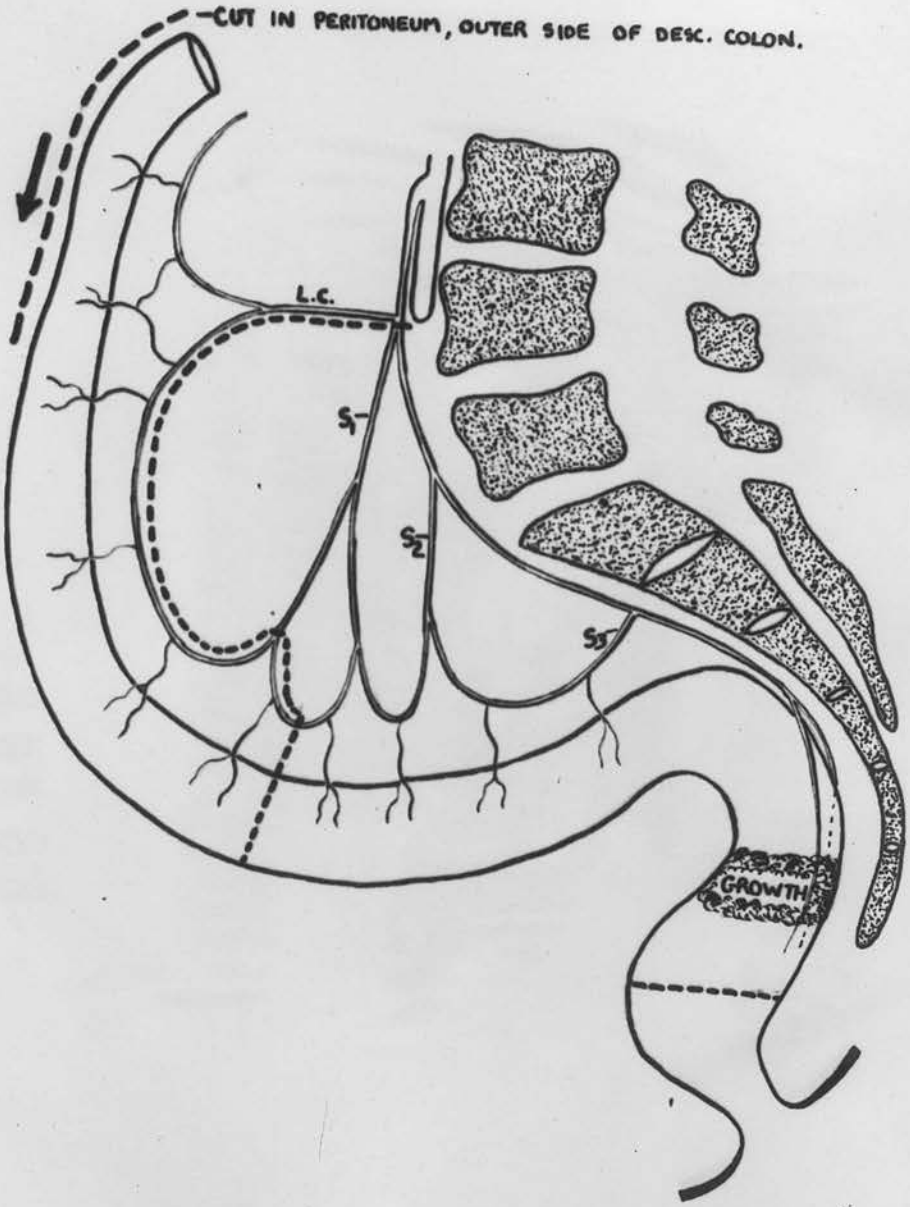


Fig.19. Diagram showing method of preparation of sigmoid stump in which the first sigmoid artery (S_1) is sacrificed and reliance is placed on the descending branch of the left colic artery (LC). This is the method preferred where possible.

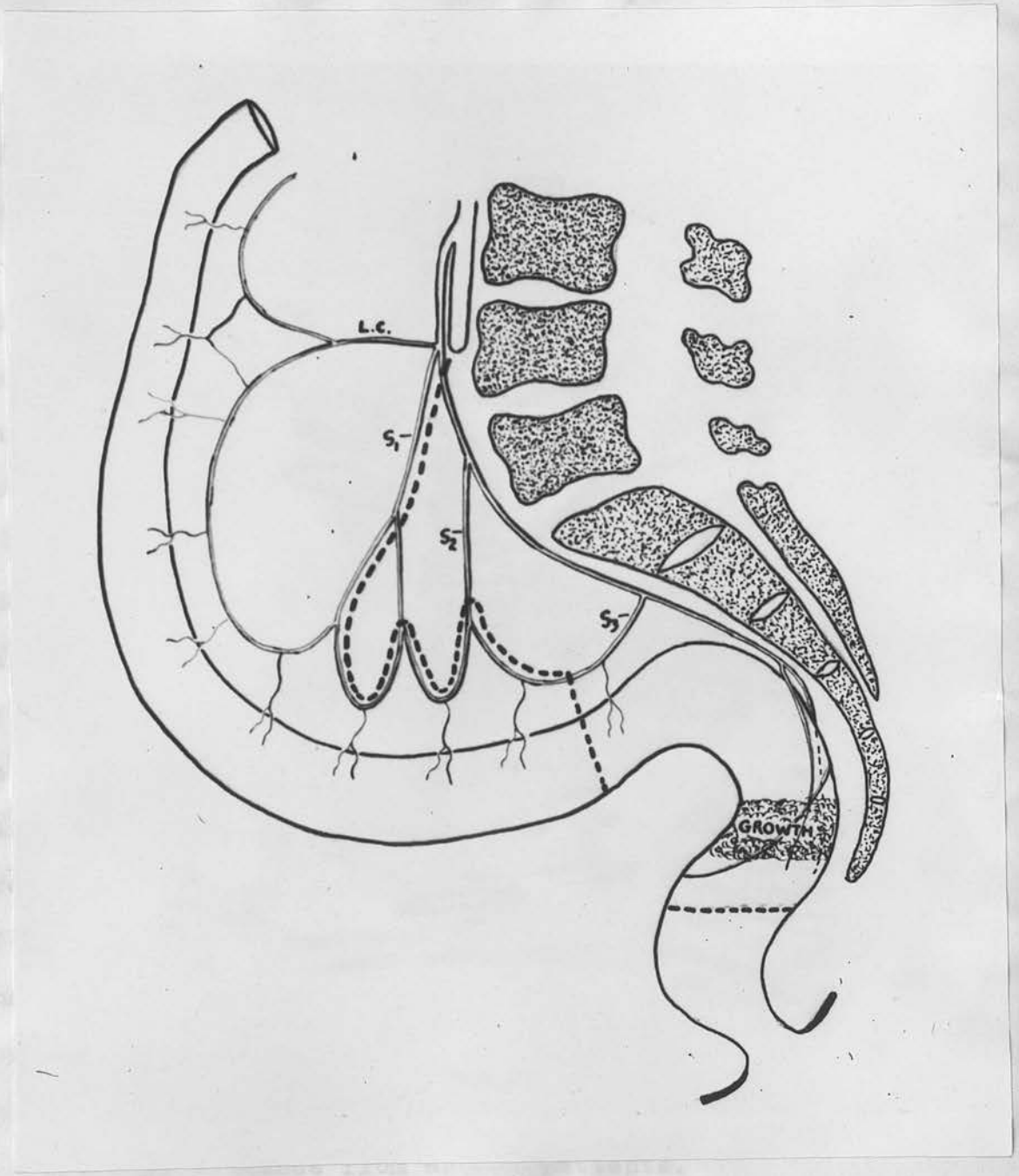


Fig. 20. Diagram showing method of preparation of sigmoid stump in which use is made of the intersigmoid marginal artery.

sectioning the bowel just below where S_1 meets it, to preserve it and the intersigmoid arcades intact for some distance below this, as shown in Fig. 20. The effect is to unroll the colon in this region, the part thus prepared being dependant on the marginal artery for its nourishment. The length obtained by this manoeuvre depends on the width of the gaps between the sigmoid arteries, which is actually very variable, but generally 2" or 3" of lengthening can be accomplished in this way.

Steward and Rankin (1933) have rightly stressed the fallacy of assuming that, because a good arterial supply can be demonstrated in post-mortem preparations of this sort, the circulation will in fact be adequate in the living subject. Many of the patients with carcinoma of the rectum are elderly and suffering from advanced arterial disease so that the possession of fair sized marginal colic vessels is no guarantee that they will transmit blood in an efficient manner. Observations such as have been recorded above cannot therefore be expected to carry much weight unless supported by evidence from actual patients. Further information has accordingly been sought from cases during operations for rectal excision.

In 18 patients the inferior mesenteric artery was tied below S_1 and the mesocolon divided as in

Fig. 17. Finally S_1 was clamped temporarily near its upper end so that the sigmoid stump was supplied solely by the descending branch of LC. The circulation in the colon was then observed, the criteria adopted being its colour, the presence of pulsation in the small arteries in its wall, particularly in the appendices epiploicae, and finally the occurrence of bleeding when one of these small vessels was divided. The fluorescin test described by Hatfield, Buyers and Walkling (1945) for determining viability of gut was also used in a few instances but was not found to be as reliable as the other simpler methods. In 14 cases the pulsations continued, though much less vigorously in 4. The colour remained good in all 18 however, by which it is meant that it stayed a pale pink and did not become blue. Arterial section invariably caused reassuring bleeding. On the strength of these data S_1 was divided and restorative resection was proceeded with in 12 cases, including one in which pulsation had ceased. The subsequent progress of these patients, whose suture lines healed without any evidence of necrosis on repeated palpations and sigmoidoscopic examinations after operation, showed that our confidence in the adequacy

of the descending branch of LC to maintain the vitality of the sigmoid stump had not been misplaced. In the other 6 cases excision was also performed but it was either a straight forward abdomino-perineal excision with terminal iliac colostomy or, if resection was employed, S_1 was not finally sacrificed, so that the apparent sufficiency of the circulation during temporary occlusion of this vessel was not submitted to the ultimate test.

With regard to the adequacy of the intersigmoid marginal arcades, the further evidence from living sources consists of observations on 8 operation cases. In these the inferior mesenteric artery was ligated below the origin of S_1 and the sigmoid arcades prepared as in Fig. 20. It was found that a satisfactory circulation could be maintained as a rule for 2" or 3" by this marginal artery. The opportunity to prove this however by proceeding to resection and anastomosis arose in only 2 of the cases; in both healing between rectum and colon took place without incident.

Of these two mechanisms for lengthening the sigmoid stump my preference is for the former because in my experience the marginal artery constituted by the descending branch of LC is generally more robust

than that formed by the intersigmoid arcades, and also because it removes the maximum amount of colon compatible with subsequent restoration of continuity and avoids the situation whereby a redundancy of bowel is present immediately above a rather taut S_1. This has pathological advantages which will be referred to later.

As a result of these observations I am confident that it will be seldom indeed that sufficient well vascularized colon cannot be made available for end-to-end union with the anorectal stump after resection. With certain resection techniques of "pull through" type, as will be mentioned later, the colon is not sutured to the upper end of the anorectal remnant but is drawn through it so as either to project 2" or so beyond or to be sutured to the anal verge. For these operations a specially long piece of colon is necessary, at least 4" or 5" longer than with end-to-end anastomosis at the lowest permissible level, or approximately 14-15" from the left iliac crest. By utilising both methods of lengthening the sigmoid stump it was found possible to obtain this quantity of bowel in 60 or approximately 82% of our post-mortem specimens; in the remainder the length of colon secured fell short of that required and in these cases abdomino-anal anastomosis would have

been impossible. One must record, however, that Bacon (1945), one of the chief advocates of the "pull through" operation, seems able to apply this technique to practically all his cases of rectal cancer deemed suitable for radical operation.

It is important to emphasize that the main ligature on the inferior mesenteric vessels in any of these 3 methods of preparing the colon stump is placed at least as high as in an ordinary combined excision. Miles (1939) recommends that in performing this operation these vessels should be tied at the level of the bifurcation of the abdominal aorta. As will be seen from Fig. 16, this will usually result in the application of the ligature just below the origin of S_1. Many surgeons at the present day make it their practise to dissect out the vessels carefully before actually tying, but even they usually end by applying their ligature immediately below S_1, as advised by Drummond (1913), because in the average case where S_1 and LC arise conjointly it cannot be placed any higher without sacrificing the latter branch, a risk few surgeons are willing to take. If S_1 and LC should be separate at their origin, as in Fig. 14, then application of the tie just below LC will be preferable in that

slightly more of the tissues of the upward zone of lymphatic extension will thereby be removed. But, as has been shown, it is also safe in doing a resection to ligate at the same point and to rely on the lower branch of LC to supply the colon stump as in Fig. 19.

Several surgeons have recommended that in performing a resection of the rectum and rectosigmoid the ligature on the inferior mesenteric vessels should be placed much lower than has here been advised, presumably in the hope of ensuring a better blood supply to the colon stump by preserving not only the first but at least one other sigmoid branch. Thus Goetze (1944) and Pannett (1947) show diagrams with the ligature just above the origin of the last sigmoid artery, i.e. the critical point of Sudeck, and Wangansteen (1945) states that it should be applied opposite the promontory of the sacrum which is about the same level. Reference to Fig. 16 demonstrates that this point is approximately 2½" below the origin of S_1 and that the operation so performed will be distinctly less radical in regard to removal of the tissues of the upward zone of lymphatic extension than an ordinary combined excision. This site is further open to the objection

that it severely curtails the length of colon stump that can be provided for "bridging" purposes. As Fig. 16 shows, though more sigmoid colon will remain after ligature below the origin of S_2 the extent to which its lower end can be drawn down is governed entirely by the length of S_2 itself, which is normally shorter than S_1. The tendency will be therefore to stretch S_2 unduly in effecting a union with the rectum, and this may imperil the circulation in this vessel and lead to necrosis. I am strongly of the opinion that it will always be safer to rely on a smaller marginal artery, that can be left completely slack, than on a larger main branch, which is under tension, and that in a restorative resection it is in the interests of both radical removal and a good blood supply to the sigmoid stump to tie the main vascular stem as high as possible. The critical point of Sudeck achieved its reputation in connection with sacral excisions; it has clearly no significance for a modern radical resection operation.

Very occasionally it will be found impossible to provide a satisfactory sigmoid stump for anastomosis after resection. This will arise not so much from undue shortness of the loop, because this can generally be overcome as already described, as from

the occurrence of conditions such as double or treble carcinomata (in approximately one case of carcinoma recti in 32), polyposis intestini (in one case of carcinoma recti in 143) or very extensive diverticulosis, in all of which the greater part of the sigmoid colon may have to be sacrificed. Excessive obesity making visualization and accurate ligation of the vessels in the pelvic mesocolon difficult might also conceivably render proper preparation of the sigmoid stump impossible.

In some of these cases resection with restoration of continuity might still be feasible by adopting the method recommended by Kümmell (1899) and Archibald (1908) of dividing the left colic artery at its origin and mobilising the descending colon thoroughly so as to enable it, supplied solely by the middle colic through the marginal artery, to be drawn down into the pelvis. They adduced evidence by injection experiments, observations in animals and a few clinical trials that the circulation would be adequate under these circumstances. The method employed successfully by Treves (1898) and more recently by Lloyd-Davies (1948) and myself is similar but perhaps safer; it consists of resecting up to the splenic flexure and then swinging down the

left end of the transverse colon nourished by the long left branch of the middle colic artery which goes to form the anastomosis of Riolan with the ascending division of the left colic. A third possibility is to utilise a loop of ileum, isolated except for its blood supply, as a graft to bridge the gap between the stump of iliac colon and the rectum, as was done by Fenwick (1914), Stone (1928) and Wangansteen (1943). For either of these latter two procedures to be possible however it is essential that the transverse colon or lower ileal coils should be particularly dependant. As a matter of interest therefore an attempt was made to determine in the 75 autopsy bodies examined how often conditions might have been suitable for the successful employment of the transverse colon or an ileal loop in this way. It was found that a stump of transverse colon could be fashioned so as to extend down to the peritoneal reflection in nearly ¾ of the cases, and in ½ it would have reached as far as the anus. In approximately half the cases also it appeared that one of the lower ileal loops might have been of value for grafting purposes after rectal or rectosigmoid resection.

The Blood Supply to the Ano-Rectal Stump.

Before leaving the consideration of vascular

anatomy, a few words should be said about the blood supply to the portion of rectum and anus remaining after resection. Quenu (1893), Drummond (1913) and Steward and Rankin (1933) have emphasized that the main artery to the rectum is the superior haemorrhoidal and that the middle and inferior haemorrhoidal vessels are of very much less importance and anastomose little with the terminals of this vessel. It might be imagined therefore that when the supply from above is cut off as in performing a resection, the contribution from the middle and inferior haemorrhoidals might prove inadequate to sustain the remaining portion of rectum and anus, especially if a long rectal stump were left as in Fig. 13. Steward and Rankin (1933) indeed considered necrosis inevitable under such circumstances, and recommended that whenever division of the superior haemorrhoidal (or inferior mesenteric) artery was necessary the whole rectum should be excised.

Practical experience with resection shows that this doctrine is entirely false. Even when a large rectal remnant is preserved at operation its cut upper edge usually bleeds sufficiently to dispel any doubt about the adequacy of its blood supply, and often the haemorrhage is profuse and embarrassing.

It is important to emphasize that this may be so even when the lateral ligaments with their contained middle haemorrhoidal vessels have in addition been divided. After operation moreover we have never observed necrosis of the rectal stump even when this was of considerable size and had been freed down to the anorectal ring. Clearly the blood supply to the rectum from below must be much more abundant than has been thought in the past. Our experience would suggest that it is derived from the inferior haemorrhoidal vessels and perhaps also from other vessels in the vicinity of the rectum as postulated by Pope and Judd (1929). During the perineal phase of a complete excision of the rectum it is striking how constantly and freely the inferior haemorrhoidal arteries bleed when cut; it is also hard to believe that the numerous vessels, which are divided and cause such sharp haemorrhage when the pubo-coccygeus muscles are severed at the side of the rectal ampulla, do not contribute to the supply of the rectum itself.

Operative Technique.

The various operations employed for resecting rectal and rectosigmoid growths and restoring continuity will now be surveyed in the light of the foregoing anatomico-pathological considerations and of our own operative experience at St. Mark's Hospital. These operations are often called conservative excisions; this, in our opinion, is an unfortunate designation because it may be taken to imply not merely that the sphincters have been conserved but also that the growth has been inadequately removed. This may be true of some of the operations of this type that have been devised but it certainly does not apply to all sphincter saving operations. For that reason the use of an expression which suggests that they are in any sense unradical is undesirable and would be better abandoned in favour of something more explicit.

Two terms commonly employed in the German literature in connection with excision of the rectum are amputation and resection. By amputation is meant removal which includes the anal sphincters, the lowest 1 or 2 feet of the alimentary tract being, as it were, amputated. Resection by contrast

indicates the taking out of a segment of rectum or colon and the subsequent restoration of continuity by end to end suture or one of the "pull through" manoeuvres. If the word resection alone is not considered forcible enough it can be strengthened by the use of a qualifying epithet or phrase, such as resection with restoration of continuity, restorative resection, sphincter saving resection.

The several resection procedures in common use can be conveniently grouped as follows :-

A. Sacral Resections.

In Germany and Austria the operation most frequently used for carcinoma of the rectum has probably been the sacral excision of Kraske (1885), which despite criticism by Kirschner (1923, 1924) and Schmieden (1924) and largely because of its comparative safety, has retained its place as the standard procedure in many German clinics. By this technique it is often possible to preserve the part of the rectum below the growth and to complete the operation by uniting the colon with this lower portion as originally advised by Kraske and even more strongly urged by Hochenegg. According to Mandl's (1922) report from the Hochenegg clinic resection

with restoration of continuity was possible in just under one half of a series of 461 sacral excisions. The technique of sacral resection has been elaborated by Hochenegg (1888, 1889), Küttner (1910, 1916), Weil (1918), Mandl (1922, 1929, 1932, 1945) and Goetze (1931). With the notable exception of Grey Turner (1932) few British or American surgeons have had any extensive experience of these operations, and for full technical details reference should be made to the publications mentioned or to a standard German Operationslehre such as the Bier-Braun-Kümmell (Sauerbruch and Schmieden 1933). Only the merest outline will here be given.

The operation is generally performed with the patient on his left, or right, side with the hips strongly flexed, but some surgeons favour the prone or "hanging belly" position of Westhues. The incision in one of its simpler forms extends from the lower end of the lowermost sacroiliac joint in a gentle curve to a point behind, and on the opposite side of, the anus. The coccyx and a variable amount of the lowest 2 pieces of the sacrum are resected and a longitudinal incision made through the anococcygeal raphe. The levator muscles are now retracted laterally, and keeping inside them the rectum and

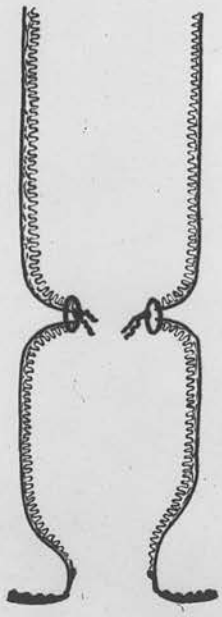


Fig. 21. Kraske operation of end to end suture.

surrounding fatty tissue are separated by blunt dissection from the side wall of the pelvis and the sacrum. In the process the lateral ligaments are divided and the pouch of Douglas opened. The upper rectum and lower sigmoid can now be pulled down so as to render the superior haemorrhoidal vessels taut preparatory to ligation. Care is taken to place this tie above the origin of the last sigmoid branch as recommended by Sudeck (1908) in order not to destroy the marginal circulation in the rectosigmoid region (see Fig. 16). If possible the peritoneum is closed again by suture to the rectum or colon before any opening is made into the bowel. The tumour-bearing part of the rectum is then excised and in the cases in which it is possible to do this as a resection with preservation of the anal sphincters, instead of amputation, continuity may be restored in one of the following ways, the application of which is, of course, not confined to sacral resection:-

(1) End to End Suture (Kraske 1885). Here the cut ends of the rectum and colon are united by simple circular suture, care being taken to invert the edges into the lumen (see Fig. 21). Usually only one layer of stitches is employed. Unfortunately, the

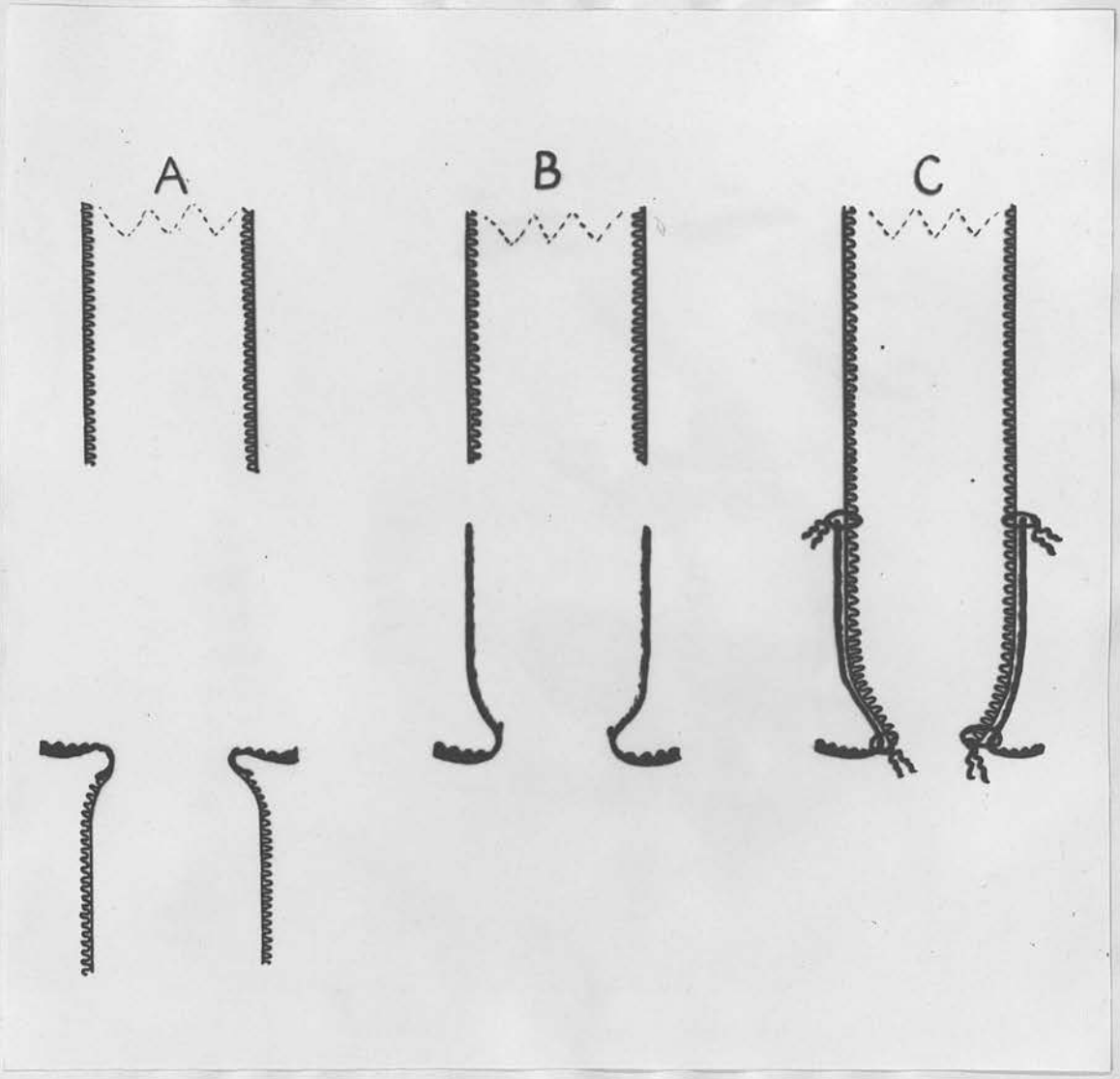


Fig. 22. Hochenegg "pull through" procedure.
A. Eversion of anorectal stump and excision of mucosa.
B. Anorectal stump returned to pelvis.
C. Colon stump drawn down and sutured to anal verge.

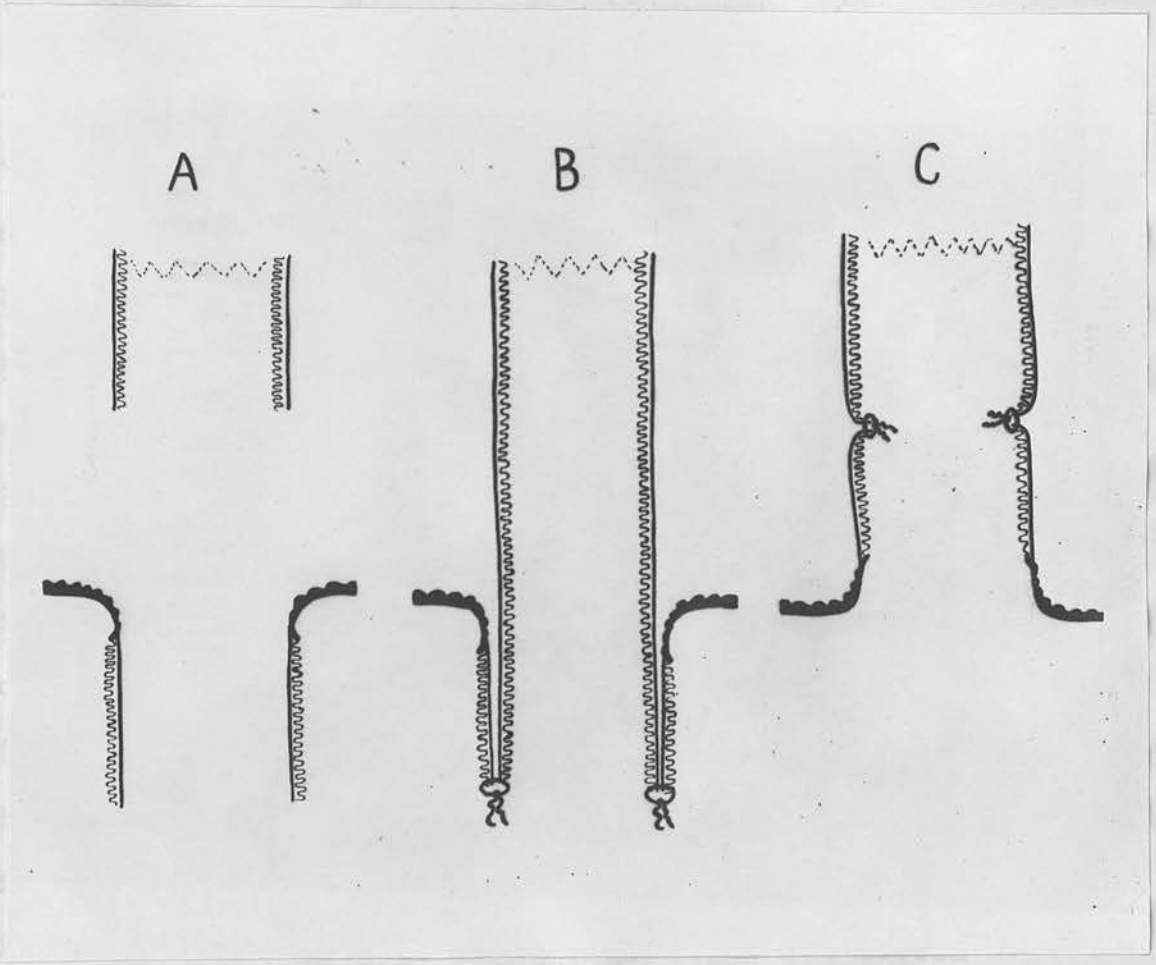


Fig. 23. Hochenegg invagination procedure.
A. Eversion of anorectal stump, mucosa not removed.
B. Colon stump drawn down and sutured to edge of everted anorectal stump.
C. Anastomosis returned to pelvis.

posterior part of the suture line generally breaks down with the formation of a temporary and sometimes permanent faecal fistula. It was to overcome this drawback that the next two methods were devised.

(2) The "Pull Through" Procedure of Hochenegg (1889). The anorectal stump is first of all everted through the anus so as to permit of the easy excision of its mucosa which then lies on its outer aspect (see Fig. 22). The stump is now returned to the pelvis, and the colon is drawn down through it and sutured to the anal skin. Mandl (1922) claimed a much lower incidence of fistulae with the technique. The disadvantage of the method is that it is extravagant in colon and for that reason it was only used in 24% of Hochenegg's sacral resections (Mandl 1922).

(3) The Invagination Procedure of Hochenegg. By this technique, as described by Finsterer (1941), a former assistant to Hochenegg, the anorectal stump is first of all everted as in Fig. 23. Its mucosa is not excised. The distal end of the colon is then drawn through the stump in the everted position and the free edges of rectum and colon united by circular suture outside the anus. When the suture is completed the anastomosis is pushed back into the pelvis. This method has never achieved much

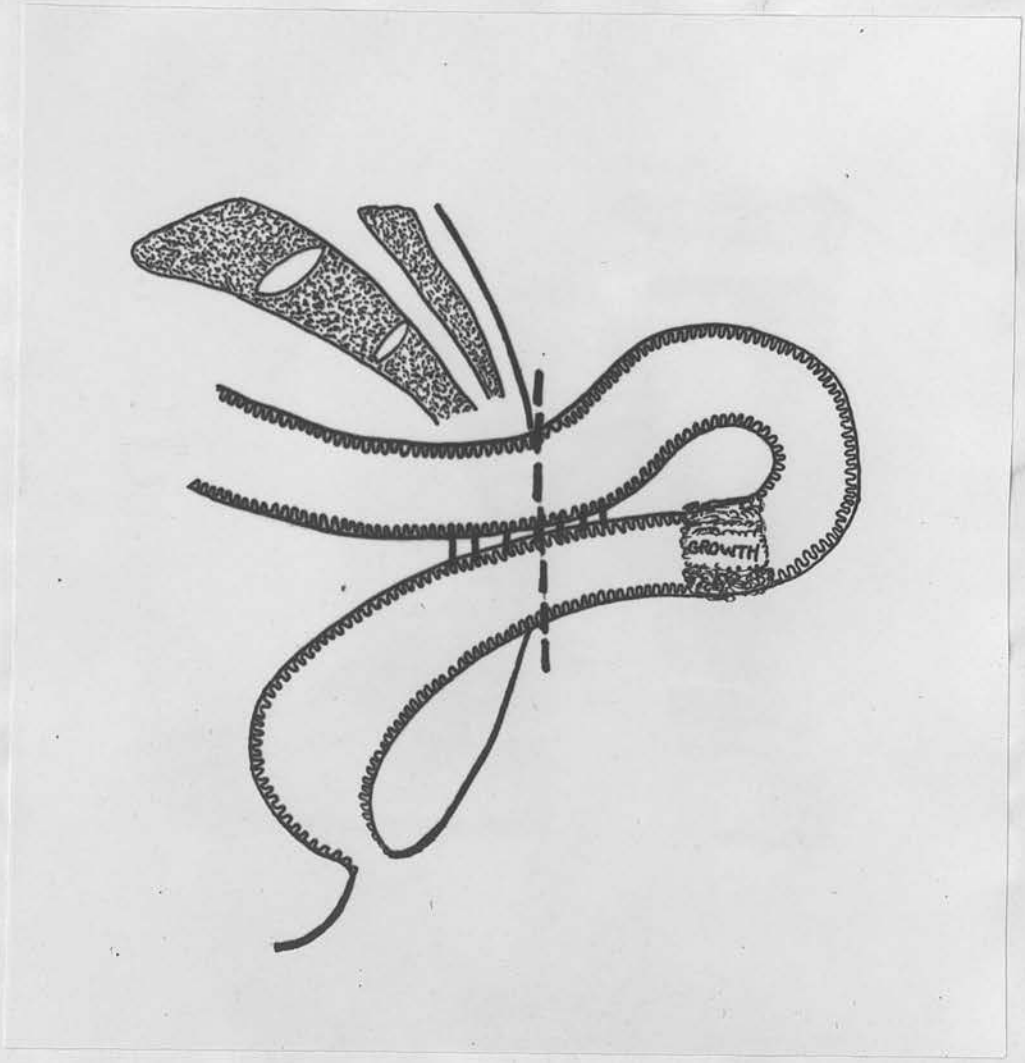


Fig. 24. Küttner exteriorization operation. Loop of bowel brought out at sacral wound and treated as in Paul Mikulicz operation for carcinoma coli.

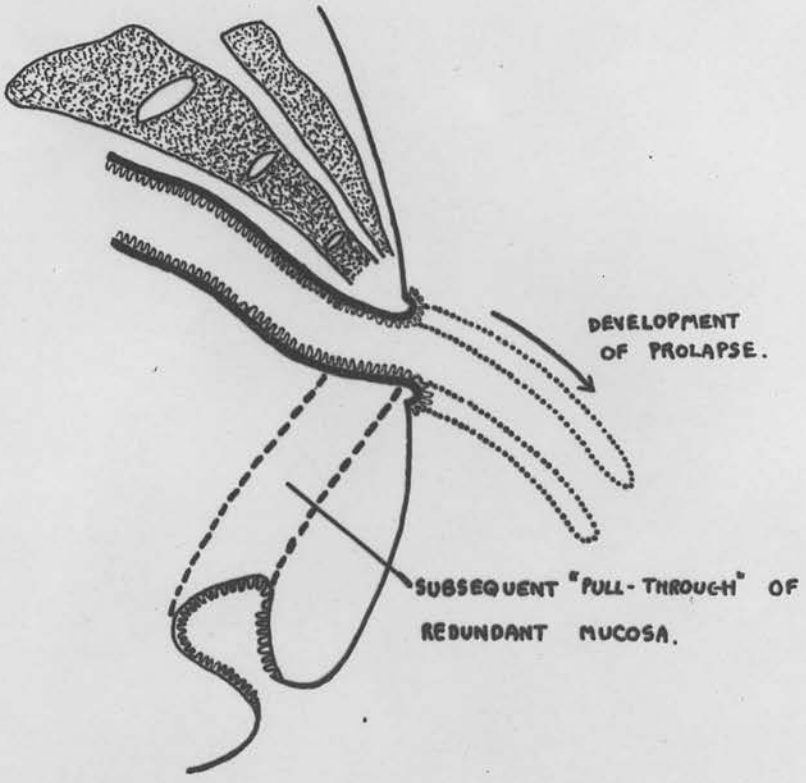


Fig. 25. Method of mucosal prolapse and secondary pull through of Weil and Mandl. Prolapse of mucosa created at sacral colostomy used to pull through to anorectal stump at later date.

popularity and as pointed out by Mandl (1922) was only rarely used even by Hochenegg himself.

(4) The Exteriorization Operation of Küttner (1910, 1916). This method is merely an application of the well known Paul-Mikulicz staged procedure for colon carcinoma (see Fig. 24). There are obvious inconveniences in applying this technique to a sacral wound, and the operation would seem to have been little practised except by its originator.

(5) The Method of Mucosal Prolapse and Secondary "Pull Through" of Weil, (1918) and Mandl (1929, 1932, 1945). This was devised for cases where approximation of the anorectal and colon stumps was impossible at the primary operation, and the colon was brought out as a sacral colostomy at the upper end of the wound, the anorectal remnant being preserved below (see Fig. 25). Prolapse of the mucosa at the colostomy is then encouraged by suitable straining exercises, and when a sufficiency of loose mucosa has been produced, it is possible by means of a small plastic operation to construct a mucous lined tunnel between colon and anus.

The operative mortality of sacral resection by any of these techniques is reasonably low when it is borne in mind that most of the statistics relate to

series that go back to the beginning of the century. The figures of 8.78% immediate mortality given by Mandl (1922) and 6.3% by Oppolzer and Nitsche (1942) are representative. As it is customary to do these operations without any form of preliminary colostomy it is not perhaps surprising to learn that 40% of the deaths in Mandl's (1929) experience were due to wound sepsis.

As for late results, a recent report by Oppolzer and Nitsche (1942) gives the 5 year survival rate for sacral resection as 37.5% (operation deaths excluded, operability rate 51.35%). It is interesting to note that their comparable survival figure for sacral amputation, where the sphincters are sacrificed, is 24.5%, the difference probably being explained by the fact that the more advanced growths carrying the worse prognosis were reserved for amputation. Mandl (1929) records 30% of 5 year survivors in Hochenegg's series of mixed sacral resections and amputations (operation deaths again excluded, operability rate 57.74%).

The functional condition after these operations has been carefully examined by Mandl (1922) and Körbl (1913). Mandl found that only 19.3% of the resection cases where circular suture had been employed were

fully continent at the time of leaving hospital; subsequently however this rose to 49.6%. Where the "pull through" technique had been used 58.3% of the cases had practically full continence early in convalescence and this later increased to 64.5%. Körbl's (1913) report from the Eiselsberg Clinic on the other hand records only 36% of cases with full continence after the "pull through" operation, but 66% after circular suture.

It is obvious that for technical reasons these sacral operations will generally be unsuitable for high growths in the rectosigmoid region, though this is not always accepted by their more ardent advocates. But even for growths in the rectum proper, where they are quite feasible technically, they are open to serious criticism. Pathologically they must be adjudged inadequate in dealing with the upward zone of lymphatic spread. Working from below it is difficult to tie the superior haemorrhoidal vessels much above the origin of the lowest sigmoid branch, 1" or so inferior to the sacral promontory being generally the highest point reached, as it used to be with the old perineal excision of Lockhart-Mummery (see Genriel 1945). Reference to Fig. 16 shows that this is at least 3" lower than is considered desirable in

a radical operation for carcinoma recti. Goetze (1931) has devised a sacral technique which he claims permits of ligation as high as the promontory itself. Even this falls short of what can be accomplished by an abdominal or combined operation. In this connection it is interesting to compare the 47.1% of 5 year survivors after combined excision at St. Mark's Hospital with the figure already quoted for sacral operations (37.5%).

Another disadvantage of resection by the sacral route is that in this operation no proper view of the vascular arrangements of the sigmoid loop is obtained, and it is quite impossible to prepare the sigmoid stump in the manner previously described so as to secure the maximum available length of colon. It is probable that the high incidence of fistulae after sacral resections is due in part to this fact and to the resulting tension on the vessels when the anastomosis is completed, leading eventually to ischaemia and necrosis. It is certainly noteworthy that leakage and fistula formation are much less common after abdominal resections, though this may be due largely to other factors.

It may be argued that sacral resection, if confined to cases without lymphatic involvement (A & B cases according to Dukes' classification -

50% of the total), is just as radical and will give just as good results as a combined excision. On the analagy of perineal excision, which as Dukes (1943) has shown, afforded results in this group of cases scarcely inferior to those obtained by the combined operation, it must be admitted that this is probably true. But the difficulty as Gabriel (1935) and Lockhart-Mummery (1935) have pointed out is to select these cases. It is impossible to be sure on clinical grounds whether lymphatic metastases are present or not. The chances of error are very considerable and the only way to reduce this to reasonable proportions is to confine the selection to the very earliest growths of small size and marked mobility, and even in this type of case mistakes may be made. Adopting these criteria Grey-Turner (1932) reckoned that less than 5% of his carcinoma recti cases were suitable for sacral resection. It is clear therefore that this operation can play little part in the radical treatment of rectal cancer. My own feeling is that while sacral, like perineal, excision may have been a valuable procedure in the days when combined excision in any form carried a formidable mortality which completely dissipated its advantages in regard

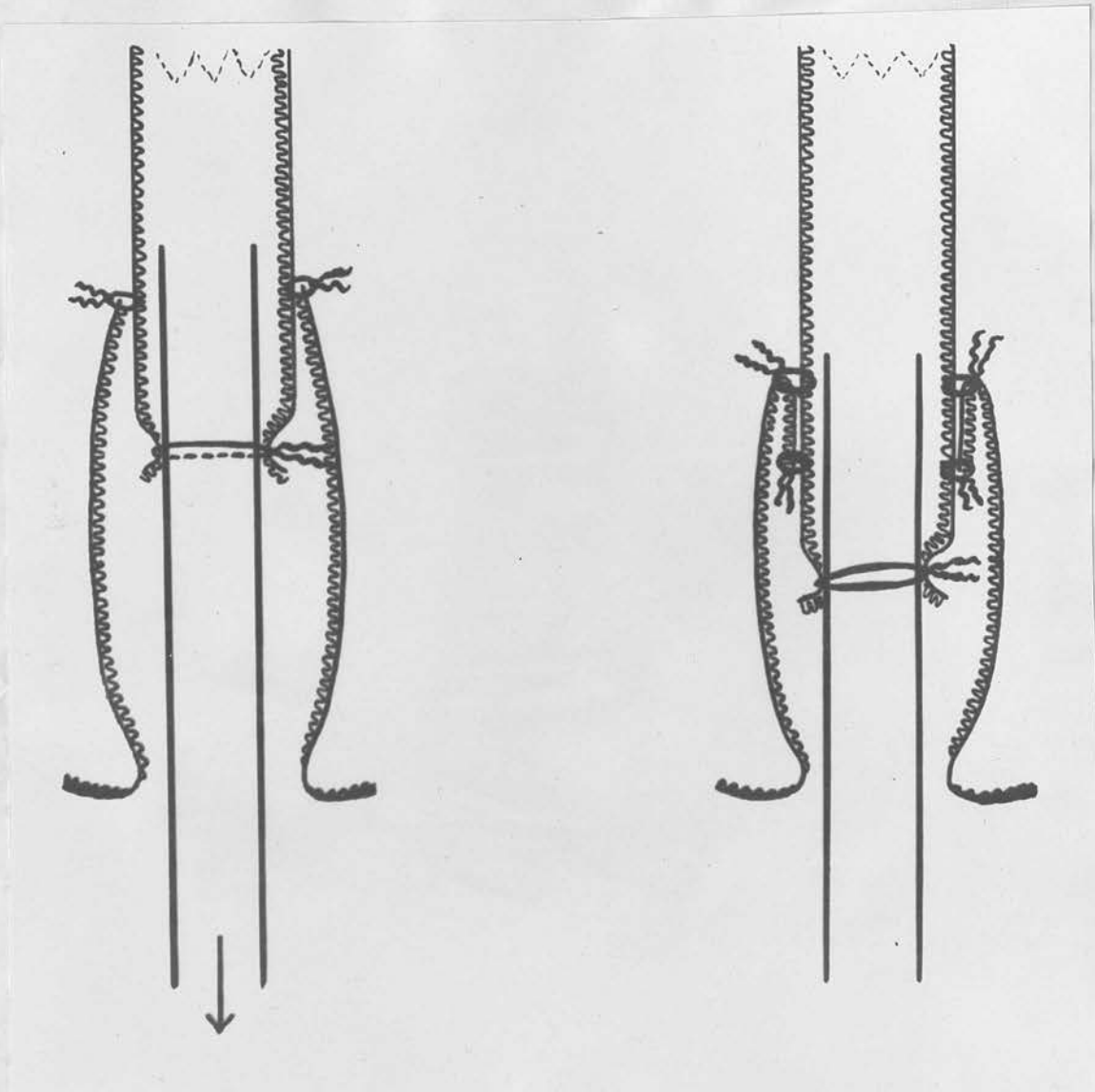


Fig. 26. Lockhart Mummery's method of recto-sigmoid anastomosis with rubber tube.

to greater protection against ultimate recurrence, at the present day its use as a routine operation is quite unjustifiable and as an occasional measure unwise and likely to be disastrous.

B. Resections with an Abdominal Phase.

(Abdominal or Anterior Resection)
(Abdominosacral ")
(Abdomino-anal ")

These all have the advantage of allowing high ligation of the inferior mesenteric vessels as in an ordinary abdominoperineal excision, so that they provide just as efficient upward lymphatic clearance as does that operation. They also permit of proper visualization of the vessels in the mesocolon and preparation of the sigmoid stump. The choice between them is determined essentially by technical considerations.

Abdominal Resection.

It is difficult to say who first employed this procedure for rectal or rectosigmoid cancer, but early reports came from Rutherford Morison (1901), Lockhart-Mummery (1908) and Balfour (1910). To obviate some of the technical difficulties of re-establishing continuity after resection in this situation they each suggested the use of a tube as shown in Fig. 26. A large rubber or metal tube

of at least ½"- ¾" internal diameter was tied into the distal end of the colon and passed through the anorectal stump dragging the colon partly inside the latter. Sutures were then placed uniting the cut edge of the rectum to the outer aspect of the colon. Further traction on the tube produced a degree of intussusception of the suture line which facilitated the introduction of a second layer of burying sutures. The tube thus secured good inversion of the cut edges; in addition it provided an initial safe conduit to the exterior for flatus and faeces from the colon without exposing the suture line to strain. However as the tube invariably became loose by the 5th or 6th day too much could not be made of this latter advantage. The portion of colon drawn inside the rectum was liable to necrose from interference with its blood supply by the sutures. It is also possible that too much reliance was placed on the tube and insufficient care lavished on the actual suturing. Anyway the method was found to be far from safe, leakage and infection being common, as admitted by Lockhart-Mummery (1934), and it was eventually abandoned.

Though a somewhat similar "pull-through" technique, with or without a tube, has again been recommended in recent years by Devine (1937) and

Bergeret & Livory (1940), most surgeons at the present day dispense with such aids and employ an ordinary end-to-end suture. Wangansteen (1943, 1945) advocates an "aseptic" anastomosis with a single layer of interrupted silk sutures inserted over special fine intestinal clamps, and Fallis (1943) and Mahorner (1946) use a similar technique with a Furniss clamp and needle, but Dixon (1939, 1946), Horsley (1937), Dunphy (1940), Pannett (1948) and Best (1948) make an open anastomosis with 2 layers of sutures, the inner usually of catgut and the outer of interrupted silk, cotton or linen. It cannot be claimed that the results show either of these methods to be superior to the other.

Abdominal resection has been reserved by Devine (1937), Horsley (1937), Dixon (1939) and Dunphy (1940) for rectosigmoid and lower sigmoid growths, but the tendency in the hands of Wangansteen (1945), Mayo (1947), Mathewson & Richards (1947), Pannett (1948) and Best (1948) has been to increase its range and to attempt resection of true rectal growths at a progressively lower level. Admittedly the deeper in the pelvis the resection proceeds the greater become the technical difficulties of the subsequent anastomosis, but with experience

and patience these can generally be overcome. Wangansteen (1945) and Mayo (1947) have both used abdominal resection for growths the lower edge of which was only 6 cms. from the anal margin on sigmoidoscopy. The lowest growth that we have resected entirely abdominally lay 8 cms. from the anus as measured by the sigmoidoscope; in our opinion 7.0 cms. would be the lowest site of growth for which resection would be pathologically justifiable.

A very debatable point is whether a preliminary or simultaneous proximal drainage vent should be established in the colon to protect the suture line from strain. Horsley (1937) and Best (1948) recommend a preliminary or simultaneous caecostomy, but a far more popular practise has been the creation of a "defunctioning" transverse (or descending) colostomy, as advocated by Devine (1935, 1937) and used by Dixon (1940, 1944) and Fallis (1943). It would seem reasonable to suppose that the complete diversion of faeces which this achieves and the opportunities which it affords for washing out the distal colon and sterilising its contents by the introduction of sulphasuccidine or sulphathaladine suppositories, ought to make the subsequent resection much safer. Undoubtedly many surgeons have been encouraged to undertake abdominal

resection by the feeling of confidence that the presence of a temporary transverse colostomy has conferred.

Wangansteen (1943, 1945) and Pannett (1935, 1943), on the other hand, have not considered a transverse colostomy necessary; indeed they have rather feared that it might predispose to the formation of a stricture at the site of anastomosis. Instead, they merely pass a large stomach tube from the anus to a point several inches above the suture line in order to avoid dangerous flatulent distension of the colon. Since the introduction of really efficient intestinal antiseptics in the form of sulphasuccidine and sulphathaladine many others such as Mahorner (1946), Fallis (1947), Mathewson & Richards (1947), Mayo (1947) and Dickson Wright (1948) have come to share this view. So far as can be judged from results the avoidance of colostomy does not seem to increase the risk of resection.

It is important to realize that while a preliminary transverse colostomy may conceivably make the resection itself less dangerous, it carries hazards of its own. Invariably a full abdominal exploration is performed at the time of the establishment of the colostomy so that the patient is subjected to the risk of a major laparotomy on this occasion as

well as when the resection is done. Thus in some ways the dangers of surgical treatment are duplicated. To avoid this we have usually compromised on the issue of colostomy at St. Mark's Hospital and made the colostomy not before but simultaneously with the resection, as Dixon (1944) apparently now does. We have relied on preoperative purgation, "washes-out" and oral sulphathaladine to cleanse and sterilise the colon as far as possible and have merely used the transverse colostomy to prevent subsequent pressure on the suture line by further faeces or flatus entering the descending and sigmoid colon. Where a tightly constricting growth is present however we have found that no amount of preoperative preparation ever succeeds in getting rid of the large hard faecal masses in the colon above the carcinoma. Despite the assurance of Wangansteen (1945) that resection with anastomosis may safely be performed even when solid faeces are present, we have never felt happy about doing so. When this state of affairs has been encountered we have either postponed the resection and contented ourselves with making a transverse colostomy at this first intervention, or alternatively have proceeded with the excision but, before making the actual anastomosis,

have milked the faeces out of the colon from the middle of the transverse to the point of section of the sigmoid, suture then being carried out and a transverse colostomy finally established. This latter procedure may seem objectionable but we have not been specially troubled with septic complications following its use. Finally it should be mentioned that we have also done a number of resections without any form of colostomy. The cases selected for this method were mostly ones in which the growth was situated in the rectosigmoid or upper rectum and the anastomosis was easily performed.

The steps of the operation of abdominal resection itself are practically identical with those of the abdominal part of the classical abdomino-perineal excision of Miles (1939) up to the stage of dividing the bowel. A very good account of the technique has been given by Wangansteen (1945). The following description is based on our personal experience of 45 resections by this method for rectal and rectosigmoid growths:-

Instruments: It will be appreciated that the dissection in these cases often takes place at a great distance from the surface, and specially long instruments are absolutely essential. Scissors

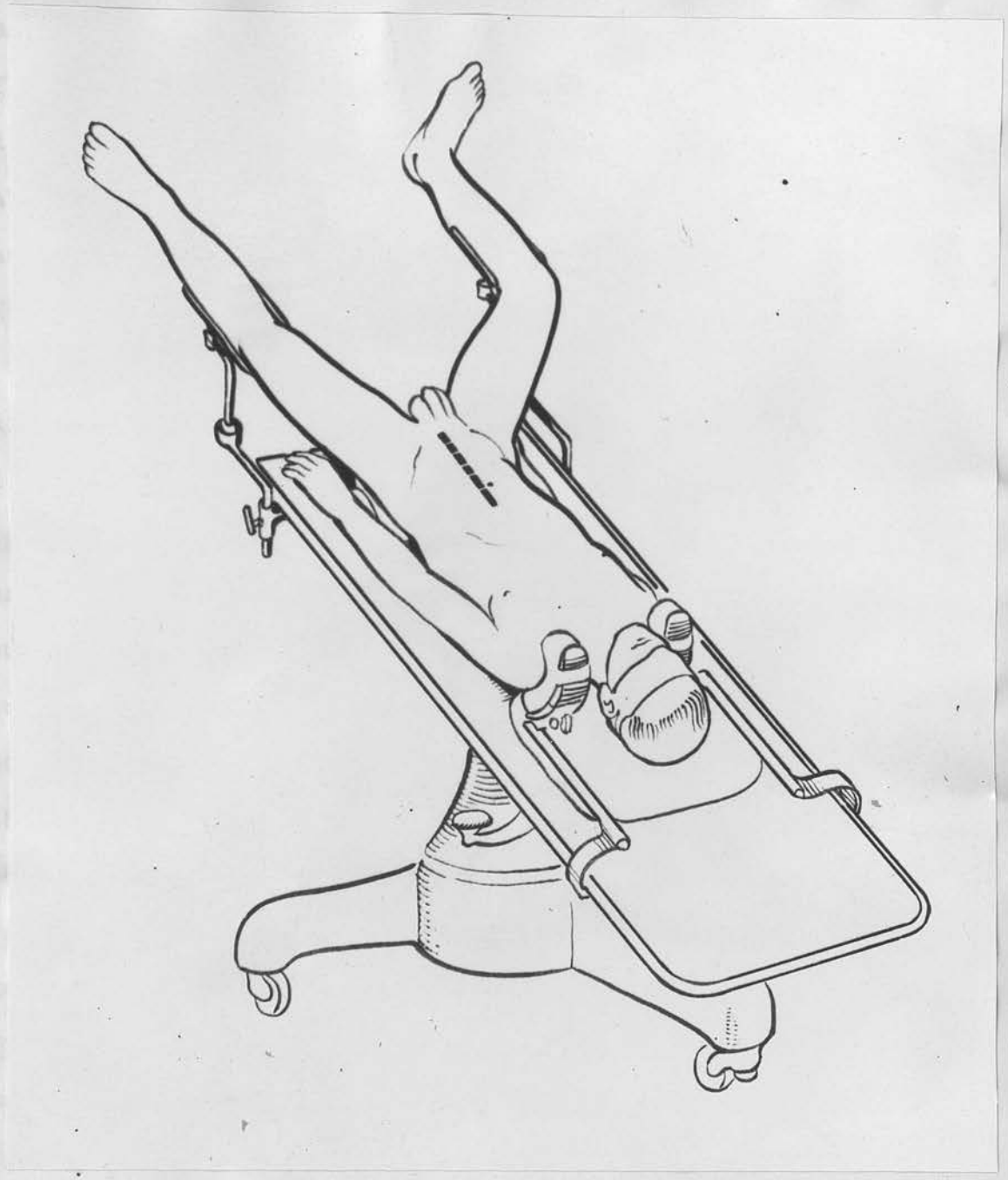


Fig. 27. Drawing showing lithotomy-Trendelenburg position of patient recommended for abdominal or abdomino-anal resection of the rectum.

at least 11" in length, and really long dissecting forceps, artery forceps and needle holders are indispensable. A good type of large self-retaining abdominal retractor such as Comyns Berkeley's, and deep bladder retractors (e.g. St. Mark's Hospital pattern) with a 7"-8" long blade are also very necessary. It need hardly be said that lighting must be arranged so as to provide optimal illumination even in the depths of the pelvis.

Anaesthetic: For ordinary combined excisions we have had a partiality for spinal anaesthesia, supplemented by general narcosis, because the fall in blood pressure which this produces has been advantageous in diminishing the blood loss during the perineal dessection. For abdominal resection, where there is no perineal phase, this advantage does not apply and we have used either spinal or general with equal satisfaction.

Position of patient: Most surgeons use the supine position with the table in a fairly steep Trendelenburg tilt. We prefer the same lithotomy - Trendelenburg position (Lloyd-Davies 1939) that we employ for synchronous combined excision for the following reasons:- (1) In our experience when the rectum is divided below the growth during a resection

there is almost invariably some faecal matter or slime present in its lumen. This holds even when a wash out has been given just before the patient comes to the theatre, because the manipulation during mobilization of the bowel, or the spinal anaesthetic, force faeces past the growth into the rectum. With the patient in the lithotomy - Trendelenburg position - (see Fig.27) it is possible for an assistant to irrigate or swab out the rectum from below just before it is opened. This saves a certain amount of contamination in the bottom of the pelvis which is difficult otherwise to avoid, even with the most expert use of the sucker and swabs. (2) This position enables the operator to change his plan of campaign from an abdominal resection to an abdomino-anal excision with the minimum of inconvenience. We have not found that the slight flexion of the thighs interferes with the abdominal and pelvic dissection.

Incision: We make a long paramedian incision extending from the pubis to 1½" or 2" above the umbilicus, the rectus muscle being retracted laterally (see Fig. 27). We have had an extensive experience of the left oblique muscle cutting incision parallel to the inguinal ligament as recommended by

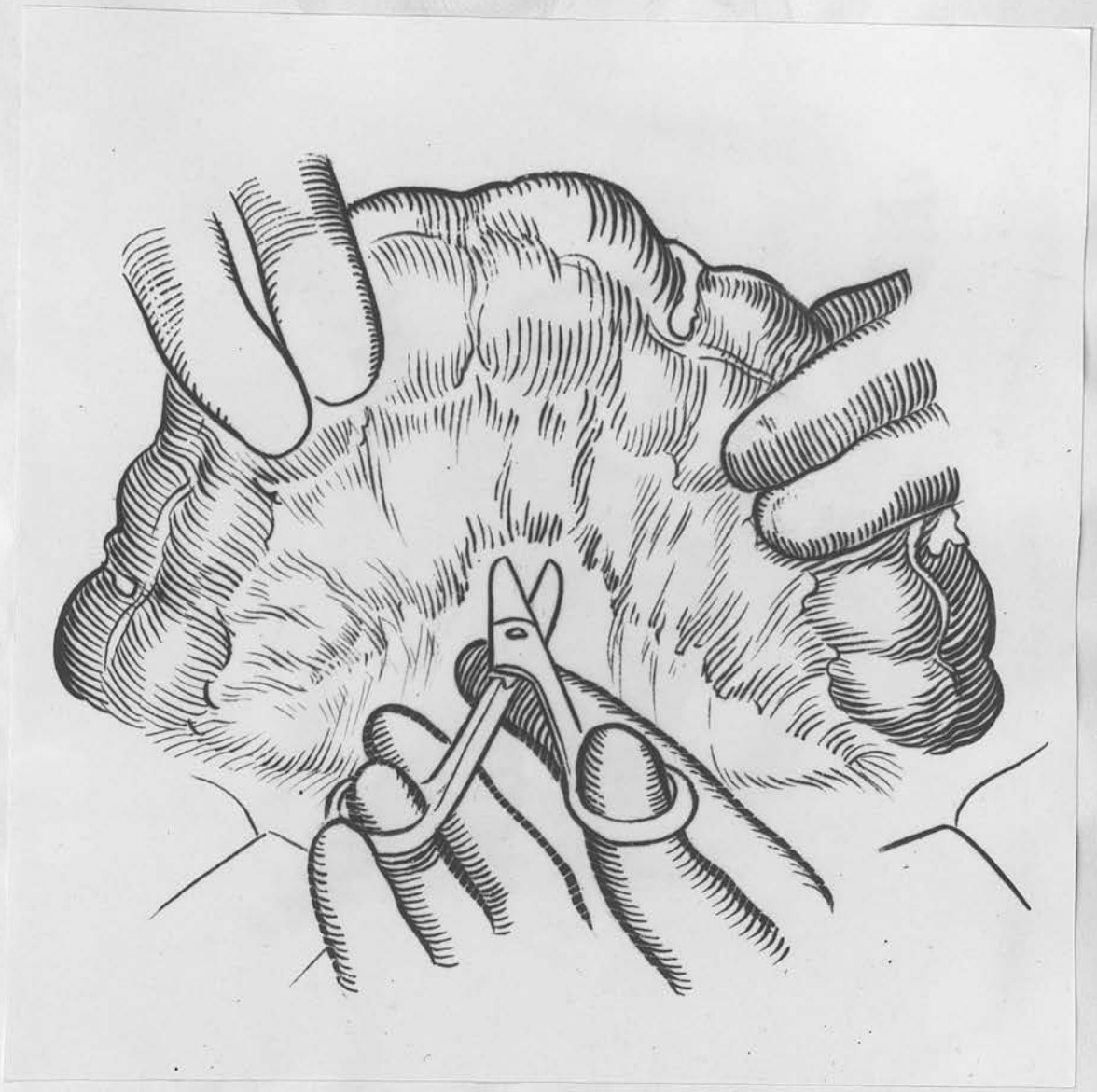


Fig. 28. Abdominal resection; division of developmental adhesions between iliac colon and peritoneum of iliac fossa.

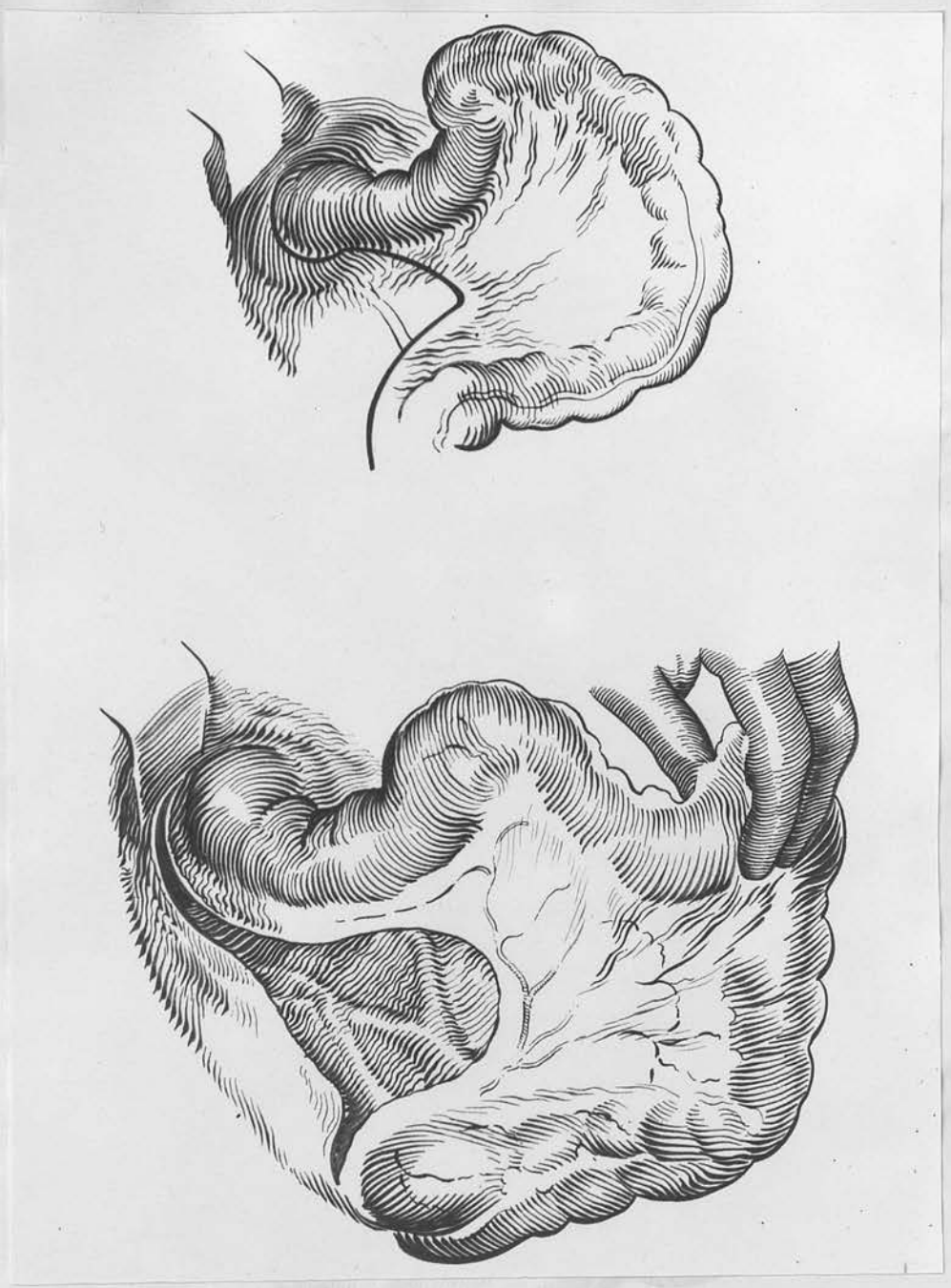


Fig. 29. Abdominal resection; incision of peritoneum along left side of base of sigmoid mesocolon.

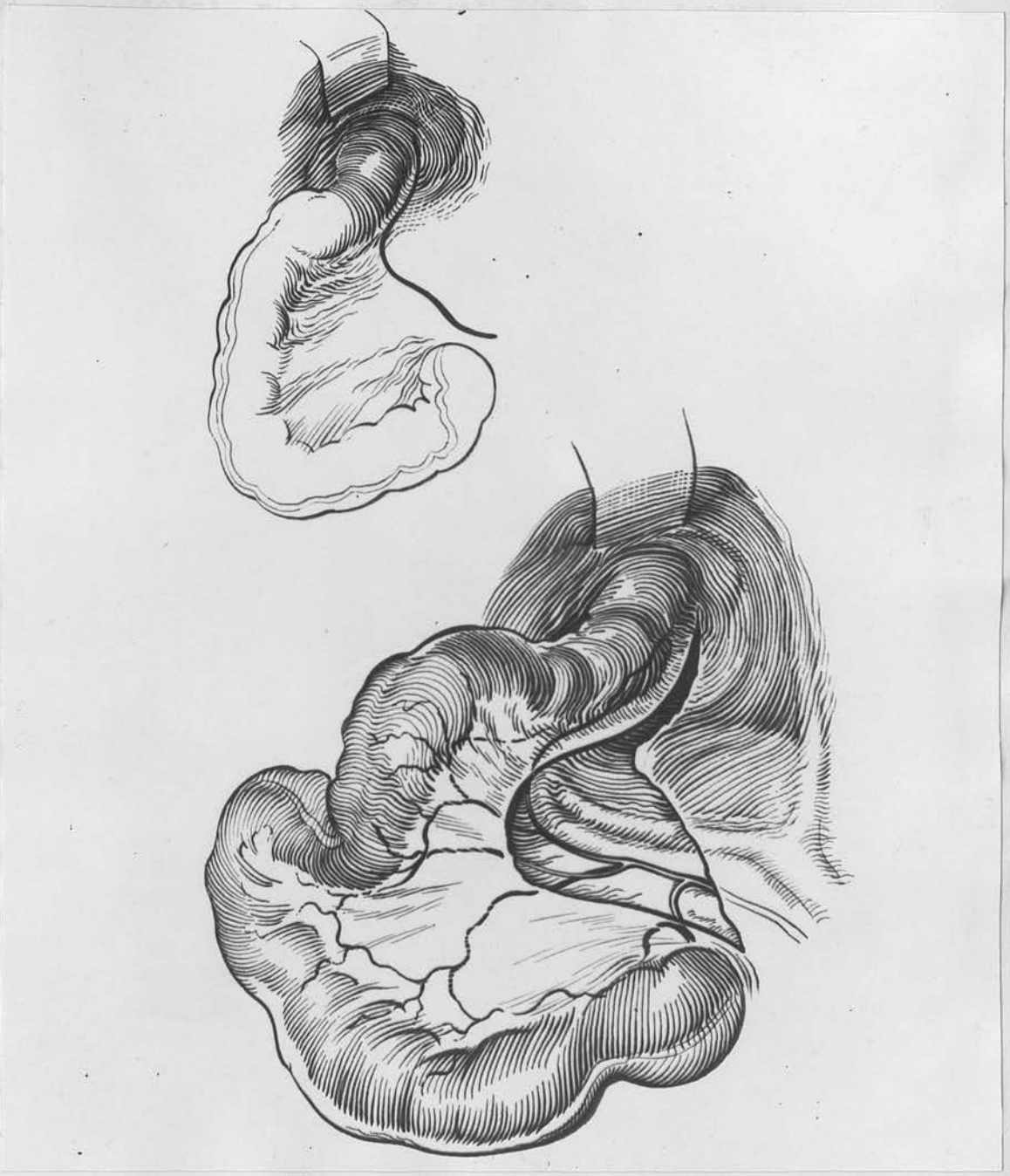


Fig. 30. Abdominal resection; incision of right leaf of sigmoid mesocolon and peritoneum or recto-vesical pouch.

Fischer (1933), Babcock (1940) and Bacon (1945) for rectal excision, and find that the access provided by it to the deeper parts of the pelvis is distinctly poor as compared with that afforded by a long vertical incision.

Exploration: The abdomen is then explored to determine the site, mobility and extent of spread of the growth, the presence of any other carcinomata or adenomata, and the state of the sigmoid colon as regards faecal loading, diverticula, and fat in the mesocolon. If conditions are suitable resection is commenced.

Mobilisation of sigmoid colon and rectum: The developmental adhesions binding the iliac colon to the peritoneum of the left iliac fossa are divided with scissors (see Fig.28). An incision is then made down each side of the base of the freed mesocolon and meeting in the rectovesical pouch in front of the bowel (see Figs.29 & 30). (If the growth lies 2" or 3" above the peritoneal reflection it is not necessary to take these incisions down to the rectovesical sulcus; they may be ended at the posterior aspect of the rectum 1" or so below the lower edge of the growth, and the peritoneum on the bowel itself left intact.) The lateral

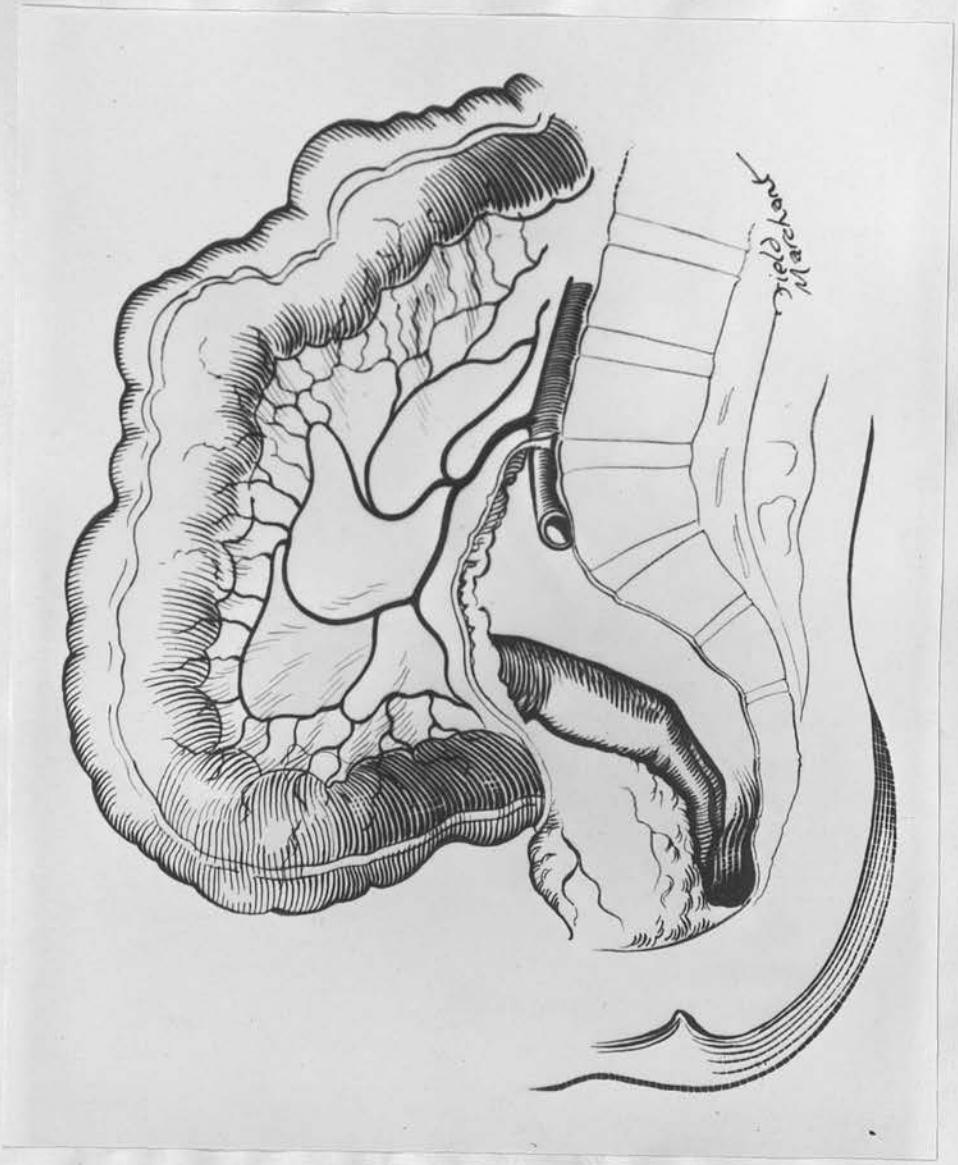


Fig. 31. Abdominal resection; manual separation of rectum from sacrum and coccyx.

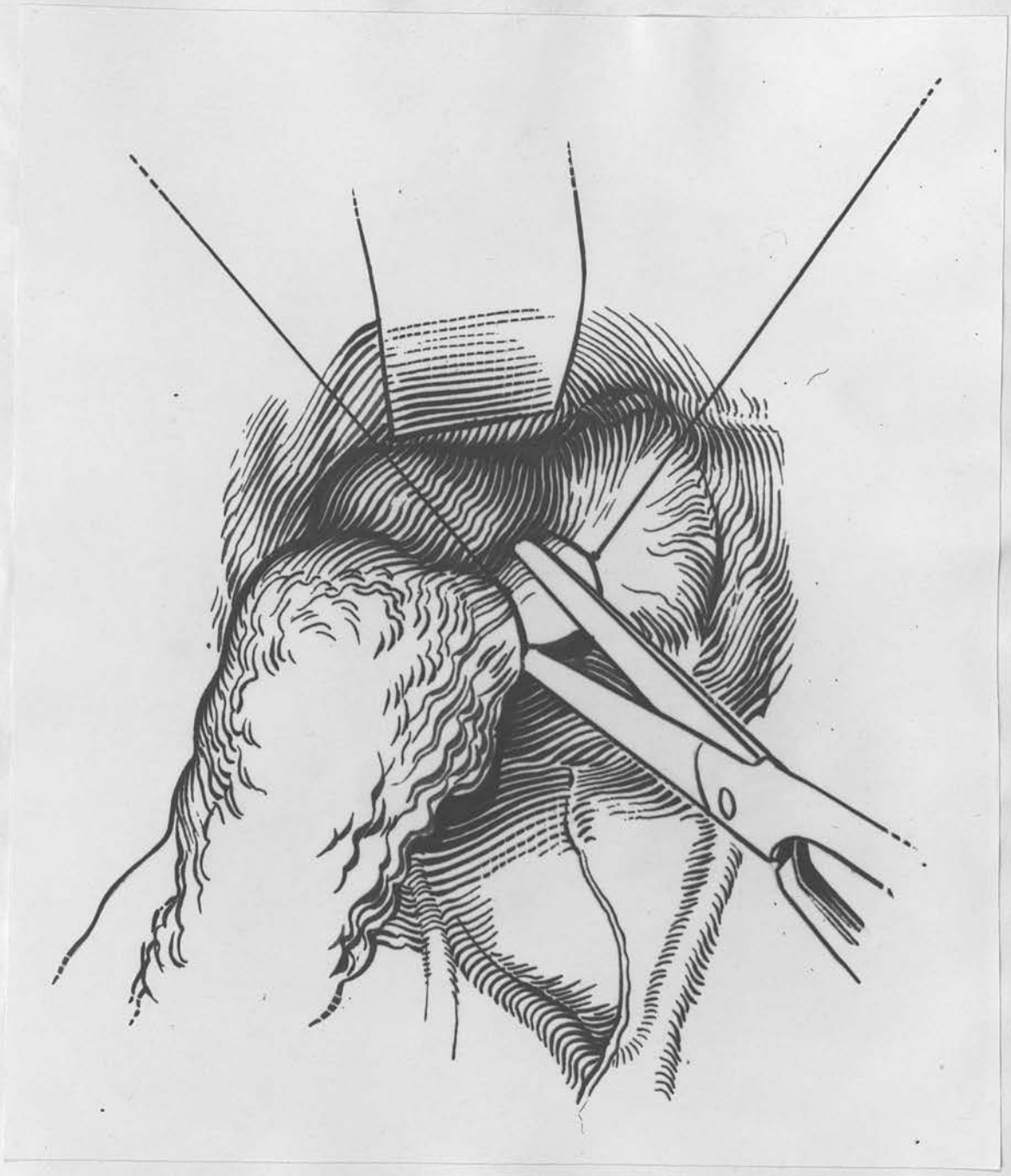


Fig. 32. Abdominal resection; division of lateral ligament between ligatures.

flaps of peritoneum are elevated to display both ureters. A hand is then introduced between the rectum and sacrum as far as the tip of the coccyx (see Fig. 31). The plane of cleavage between the rectum and bladder or vagina is now sought in front, and separation effected as far as the apex of the prostate or corresponding level in the female. Once the separation has been started with scissors the best instrument for the purpose is the index finger. The lateral ligament on either side now remains to be divided in order to free the rectum down to the anorectal ring. As the middle haemorrhoidal vessels contained in these ligaments are sometimes large enough to give rise to troublesome bleeding we prefer to tie the ligaments where possible with ligatures passed by an aneurysm needle before dividing them (see Fig.32). In male cases with bulky growths this is sometimes difficult to do. (Again if the lesion lies 2" or 3" above the peritoneal reflection it may not be necessary to take the dissection as far down as this and the lateral ligaments can usually be preserved intact.) It will be found that after the rectum has been mobilised in this way it can be lifted up out of the concavity of the sacrum and straightened out so that the growth rises 2" or so in the pelvis.

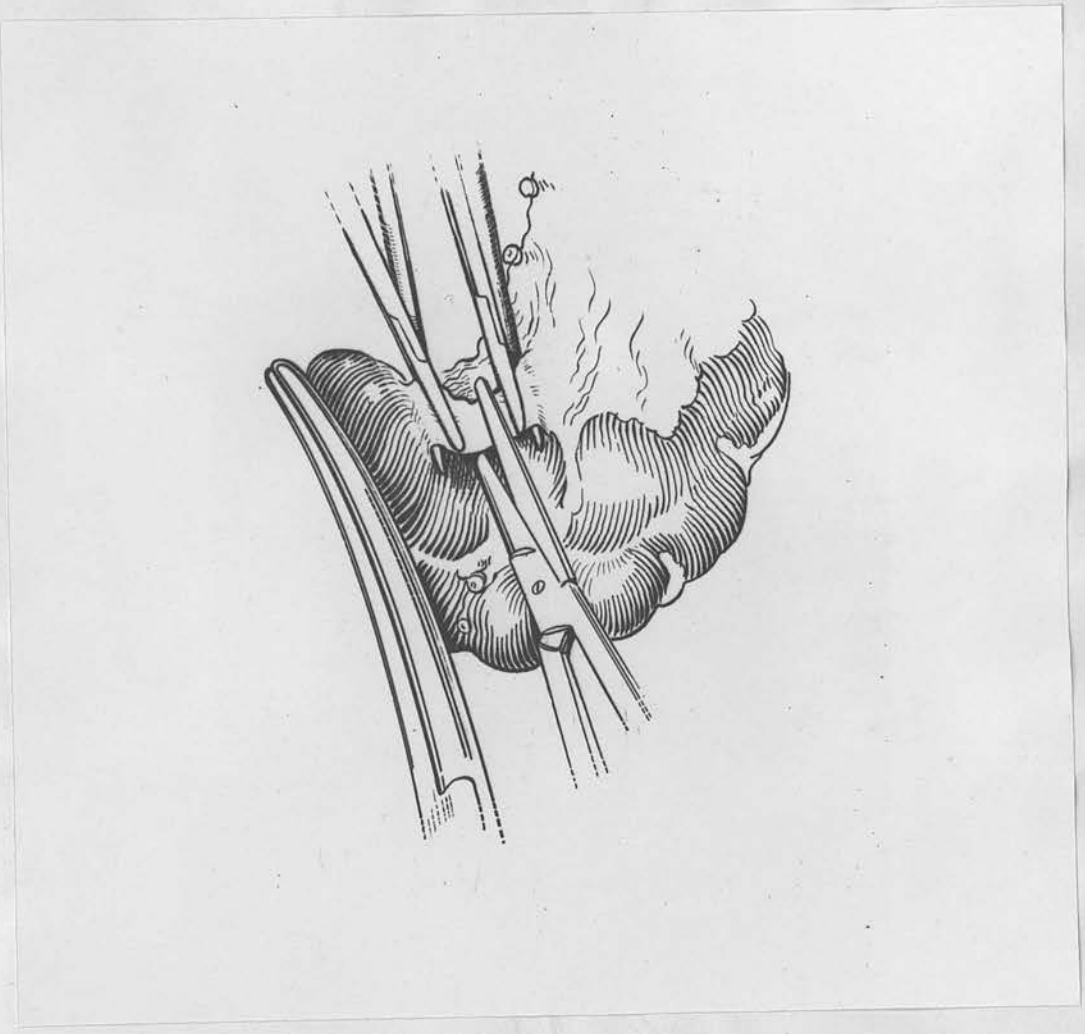


Fig. 33. Abdominal resection; preparation of end of colon stump for anastomosis by removal of appendices epiploicae from terminal ½".

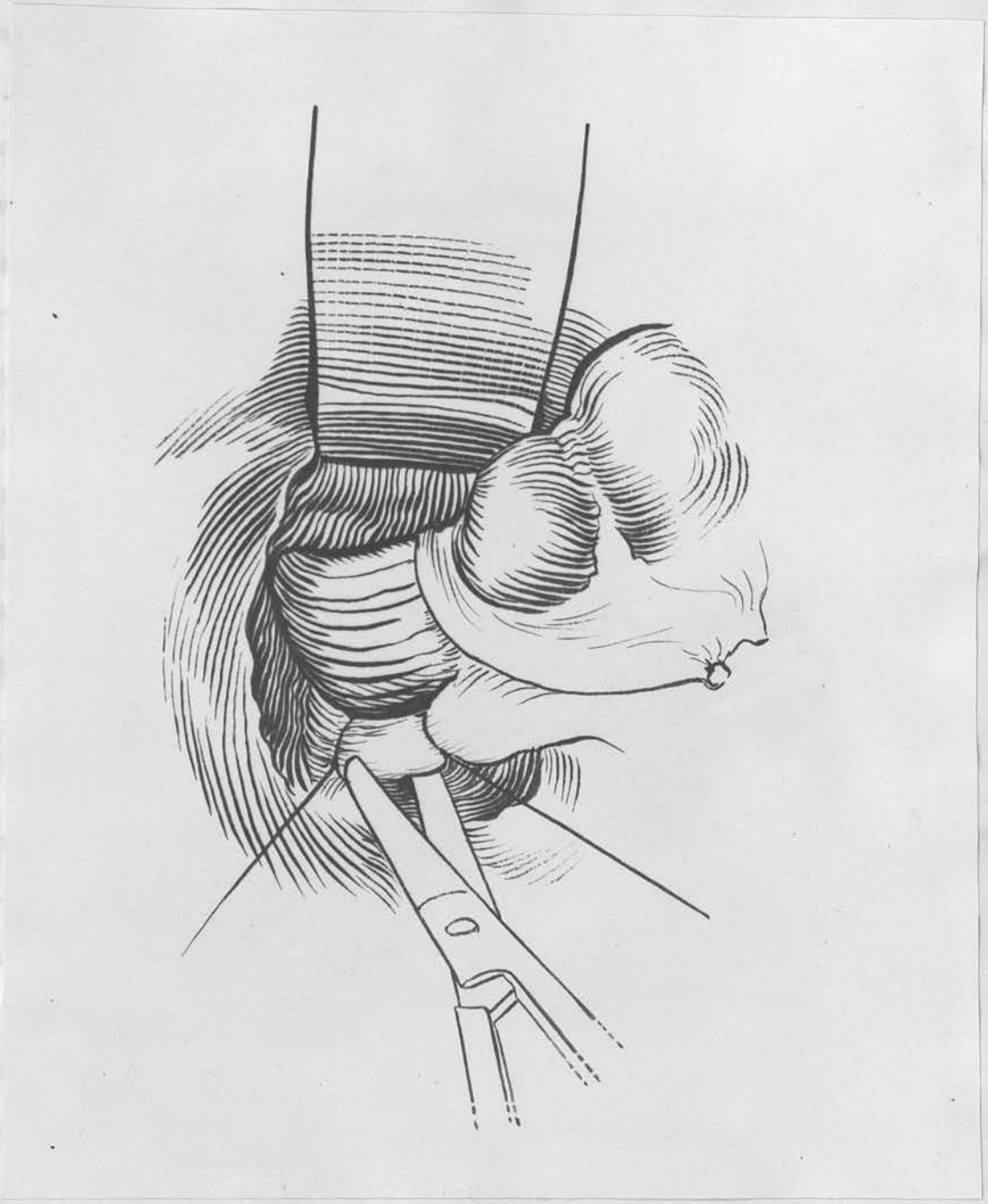


Fig. 34. Abdominal resection; dividing the meso-rectum below the growth.

Preparation of the sigmoid stump: The vessels of the sigmoid loop can now be carefully examined as in Fig. 16. In a thin patient they will be very obvious, but in a stouter subject it will be an advantage to shine a light through the elevated mesocolon so as to render them conspicuous. The inferior mesenteric artery is then tied and a suitable length of sigmoid colon prepared as in Figs. 17, 19 or 20; whenever possible the plan of Fig. 19 is adopted. The colon is then doubly clamped at the point selected for section, the clamp being placed obliquely so as to increase the lumen for anastomosis and secure a good blood supply to all parts of the cut edge. Just before or after clamping and dividing, the stump is denuded of appendices epiploicae at its terminal ½"-¾" to facilitate subsequent suturing, (see Fig.33); the bleeding that occurs in the process also provides reassuring evidence of a satisfactory blood supply.

Preparation of the rectal stump: Attention is now turned to the mesorectum containing the terminal branches of the superior haemorrhoidal vessels below the growth. At a point at least 1¼" below the lower margin of the main tumour mass the meso-rectum is carefully separated from the back of the

rectum by cholecystectomy forceps and gauze "pushers", doubly tied and divided (see Fig.34). The distal ligated pedicle will now retract somewhat or can be brushed downwards so as to leave the rectum completely bare right round for some 1½" below the lower edge of the growth. Parker Kerr clamps can now be applied and the rectum divided 1" inferior to the carcinoma. We find it more convenient to use curved Parker Kerr clamps, applied in the antero-posterior plane with the handles just above the pubis and the concavity upwards, than any form of right angled clamp.

The Anastomosis: We have invariably employed an "open" technique in anastomosing colon to rectum. Stay sutures are inserted anteriorly and posteriorly in the upper end of the rectal stump and the Parker Kerr clamp removed. The crushed edges usually separate immediately and bleed, sometimes profusely. The clamp is now also taken off the colon stump, and if necessary faecal masses milked out of it into a kidney dish, this being done outside the wound. The cut edge of the colon is then approximated to the rectal stump by two catgut stitches uniting the mesenteric and antimesenteric borders of the colonic lumen to the region of the posterior and anterior rectal stay sutures respectively. A

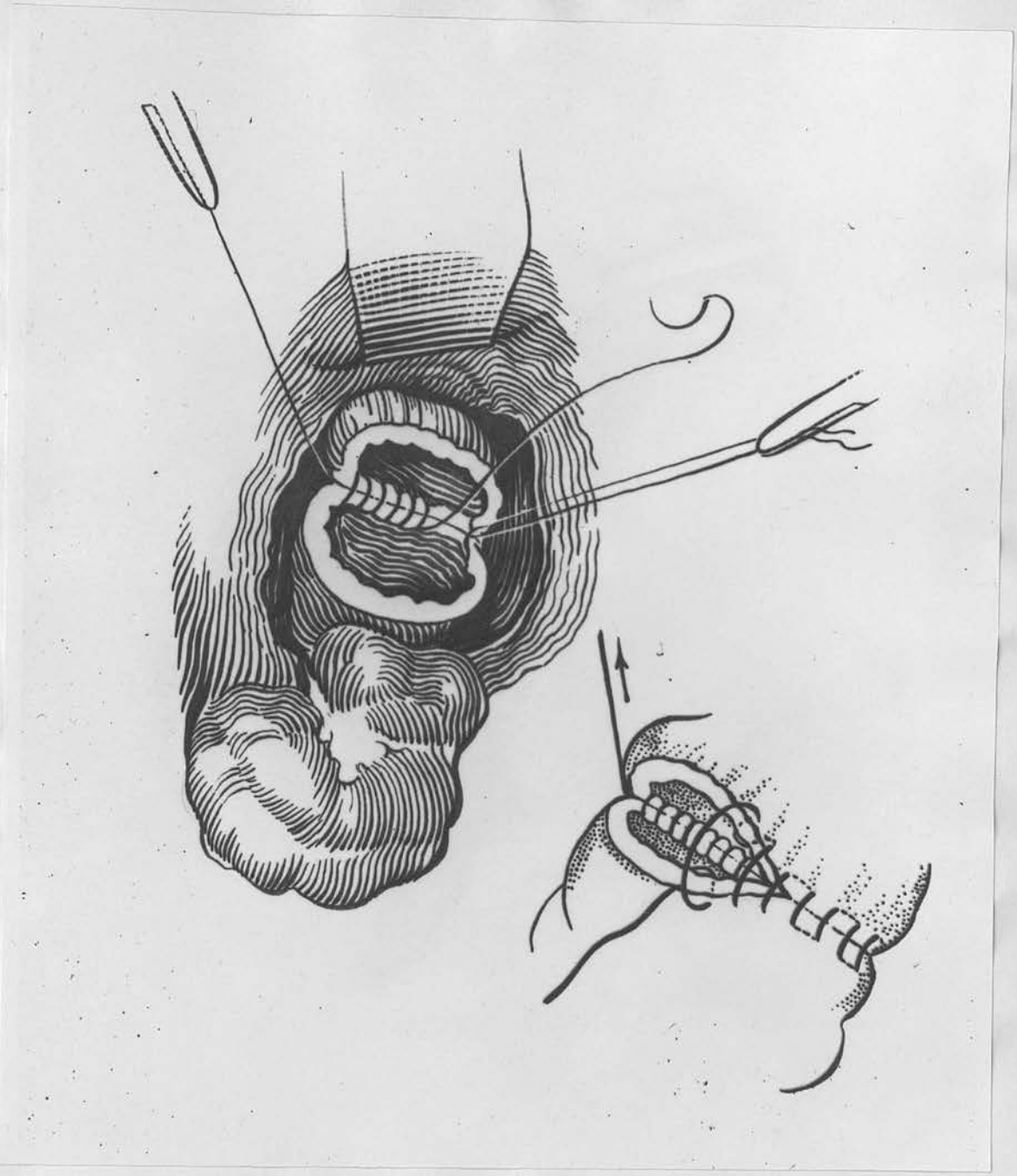


Fig. 35. Abdominal resection; anastomosis between colon and rectal stumps, continuous through-and-through catgut suture being inserted. Inset, note use of Connell stitch for second half of circumference.

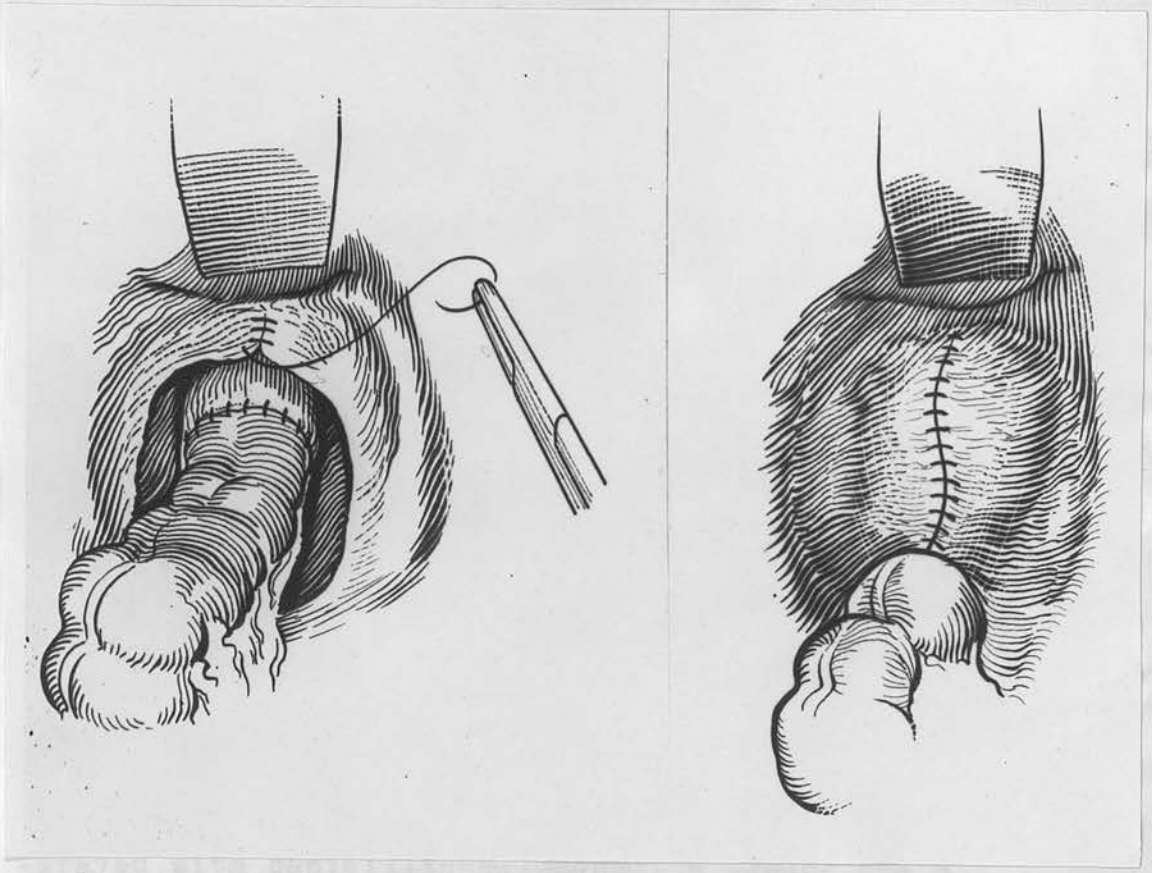


Fig. 36. Abdominal resection; suturing of peritoneum of pelvic floor so as to place anastomosis extraperitoneally.

continuous catgut stitch is now inserted all round between colon and rectum, the first half being taken as an ordinary overstitch, the second on the Connell principle (see Fig.35). When this is completed the edges of colon and rectum will have been accurately co-opted with good inversion. In a number of our cases no further sutures have been inserted but in the majority we have added another layer of interrupted serum proof silk sutures to bury the anastomosis further. This is carried out by rotating the anastomosis first to one side and then the other, the antero-posterior plane of the mesenteric axis at the site of anastomosis permitting this to be done with the minimum of strain on the vessels in the mesocolon.

Reperitonealization of Pelvis and Drainage: The site of anastomosis and the depths of the pelvis are now sprayed with penicillin-sulphonamide powder and a drain inserted down to them through the bottom end of the abdominal wound; this passes through the rectus muscle and beneath the peritoneum above, or at the side of the bladder. The peritoneal flaps on either side are then sutured so as to reconstitute the covering of the pelvic floor, the anastomosis being placed subperitoneally (see Fig.36), and the colon sutured to the peritoneum where it passes

through on its way to the anastomosis. In two cases we brought the drain out through a para-coccygeal stab incision and in 5 dispensed with drainage entirely. Though drainage from below is more satisfactory from the mechanical point of view, we have avoided it largely because of the risk of secondary infection in this situation or of faecal fistula formation. We think that if they are to do any good drains should be retained for at least a week wherever they are inserted.

Transverse Colostomy or Rectal Tube: If a transverse colostomy is considered necessary it is established at a separate short transverse incision through the upper part of the R. rectus muscle. It is opened on the table after the main wound has been closed. If the alternative of passing a large stomach tube per anum is preferred this should be introduced by an assistant before the peritoneum of the pelvic floor has been sutured, so that its point can be safely directed through the anastomosis by the surgeon's fingers.

Closure of the abdomen: The parietal wound is then closed, and in view of the age and poor general condition of many of these patients we have usually employed non-absorbable suture material, such as stainless steel wire or nylon, for all layers.

In our experience these operations can seldom be completed quickly. If the growth happens to lie in the rectosigmoid several inches above the peritoneal reflection, resection need not take any longer than a combined excision, but where the anastomosis is conducted deep in the pelvis, as is usually the case, the operation time in our hands has been in the region of 2 to 2¾ hours. Despite this, it is our impression that the amount of shock produced by these prolonged operations is distinctly less than by a combined excision, and this we attribute to the absence of the perineal dissection and its attendant haemorrhage and trauma. The patients' comfort and mobility after operation are also strikingly increased by their freedom from a perineal or sacral wound.

In the St. Mark's Hospital series of 45 abdominal resections there have been 5 hospital deaths. One was due to a coincidental perforation of a gastric ulcer, which, occurring at a time when the patient was suffering from a good deal of postoperative abdominal discomfort and paralytic ileus, was not recognized clinically and proved fatal. Another was due to haemorrhage and shock during one of our earliest and most difficult

resections which lasted nearly 3½ hours. Of the remaining 3, one was an anaesthetic death and the other two were attributable to cardiac failure and uraemia respectively. This gives an operative mortality of 11.1% which is practically identical with that of combined excision at St. Mark's Hospital during the same period - namely 10%. It is definitely our impression that abdominal resection need not be any more dangerous than a combined excision.

Particularly noteworthy is the fact that though we have had septic complications no case has been lost on account of them. A pelvic abscess developed in 5 cases, bursting into the bowel lumen in 3 and into the vagina in the others with the formation of transient rectovaginal fistulae which eventually closed spontaneously. Three of these cases were derived from the group of 27 patients whose resections were accompanied or preceded by the establishment of a transverse colostomy. The other two arose in the smaller series of 18 cases done without colostomy; after the occurrence of the abscess a transverse colostomy was performed in one of these cases also.

In 3 of the cases complicated by abscess formation the anastomosis broke down in the posterior 1/3rd of its circumference but once the abscess had discharged healing took place with surprising

rapidity so that the gap was completely closed in 2 or 3 weeks. In all our other cases the suture line united perfectly. Though considerable narrowing of the lumen was present at the site of anastomosis at the conclusion of operation, after 10 to 14 days this widened somewhat, and this process of dilatation continued, presumably due to the passage of faeces so that months after the operation the suture line though still palpable as a fibrous ring was usually wider than it had been whilst the patient was in hospital. In no case was any form of instrumentation or proctotomy necessary to widen the region of the anastomosis. We should explain that in the cases done with a colostomy it was our policy to break down the colostomy spur as soon as possible so as to restore the faecal stream to the rectum and avoid a narrow stenosis. Unless septic complications supervened, therefore, the enterotome was generally applied 7-10 days after resection, which meant that the bulk of the faeces were passing per rectum in about a fortnight from the time of the main operation. At this stage the colostomy patients were discharged, the final closure of the remaining opening being undertaken 6 weeks later when all oedema had subsided. This usually only detained them in

hospital for 5-7 days, so that the total period of hospitalization for these cases was only about a week longer than for those done without colostomy.

As for functional results, a few of our cases with very low resections have been a little uncertain of themselves during the first few days after faeces started to pass per rectum, but within a week or so they have all had 100% continence and been able to distinguish perfectly between faeces and flatus. Initially most of them have had rather frequent motions, generally twice or thrice a day. This is presumably due to the fact that the main colon reservoir for faeces has been reduced by the excision of part of the sigmoid loop. Adaptation occurs however in due course, and after a few months most of the cases have only one or at most 2 motions a day.

With 4 exceptions our abdominal resections have all been done in the past 12 months and we are therefore unable to offer any useful information as to the ultimate survival rate. Indeed very few reliable data exist on this point as yet. Dixon (1944) is the only surgeon with a large number of cases performed sufficiently long ago to be of any value in this respect but even he can

only give 3 year survivals. It should be remembered that his cases so treated were suffering exclusively from rectosigmoid growths. Giving his resectability rate as 82%, he refers to a series of 181 cases treated by abdominal resection with an overall mortality of 12.1%. 104 operation survivors who had had their operations done more than 3 years previously were followed up; 102 were successfully traced and 60 or 58.8% of these were alive and well. In terms of A, B & C cases (Dukes' classification) the survival rate was as follows :-

Operation survivors	Alive & well 3 years later	3 year survival rate
A cases 27	22	81.35%
B " 46	25	54.3 %
C " 31 (29 traced)	13	44.8 %

For comparison we would record the following figures relating to a series of 514 cases treated by combined excision at St. Mark's Hospital. These include rectal and rectosigmoid growths.

Operation survivors	Alive & well 3 years later	Alive & well 5 years later
A cases	89.2 %	83.9 %
B cases	78.2 %	62.3 %
C cases	41.5 %	31.0 %
A,B & C cases together	59.1 %	47.1 %

Operability rate was approximately 75%.
Operative mortality - 15.0%.

Abdomino-Sacral Resection.

This method was apparently introduced in 1899 by Kraske (1905) to overcome the pathological inadequacy of his older sacral operation. It has been employed mainly in Germany, Finsterer (1941) and Goetze (1944) being its chief supporters at the present day, but Pannett (1935, 1943) in this country and Arnold (1939), Wilensky (1942, 1945) and Best (1948) in America have also advocated its use.

The operation consists essentially of a combination of the dissection required for abdominal and sacral resections. The abdominal phase proceeds up to the stage of preparation of the blood supply to the sigmoid stump but stops short of division of the bowel. Instead the loose sigmoid loop and rectum are pushed down into the pelvis and the peritoneum of the pelvic floor sutured over them. The abdomen is then closed and the patient turned on his side. A sacral dissection is now performed the rectal stump prepared and the bowel resected; restoration of continuity is effected by one of the methods already described in connection with sacral resection. Both Finsterer (1941) and Goetze (1944) make a preliminary transverse colostomy several weeks before the resection.

As for results Finsterer (1941) records an operative mortality of 18.4% in his series of 103 cases which extends back to 1915. Goetze (1944) had 5 deaths in 29 cases. The only worth-while report of late results is that of Finsterer (1941); 46.1% of his operation survivors lived 5 or more years after operation. One gathers from Pannett's (1935, 1943) articles that a faecal fistula through the sacral wound occurred in most cases, but closed spontaneously. Finsterer (1941) and Goetze (1944) seem to have been less troubled by this complication. Most cases apparently enjoyed full continence eventually.

We have no personal experience of this operation and we are not quite sure what place it should occupy in the management of rectal carcinoma. As already pointed out the method of abdominal resection has been so developed in recent years that the majority of rectosigmoid and rectal growths suitable for a restorative procedure can be dealt with entirely through the abdomen. Though the actual anastomosis in some of the lower growths would probably be more easily performed through a sacral approach there is much to be said for avoiding the addition of a sacral wound if possible. It

magnifies the amount of shock, it is liable to become infected and to form septic or faecal fistulae, and it increases the burden of discomfort after operation. It is significant that Pannett (1948) has largely given up the abdomino-sacral method in favour of abdominal resection. For growths between 7.5 and 10 cms. sigmoidoscopically from the anus, however, particularly in males with narrow pelves, a purely abdominal resection is sometimes extremely difficult and it is possible that an abdomino-sacral technique might be preferable in such cases, though here it has to compete against abdomino-anal operations. It has one advantage over them however, in that the sigmoid stump required for it is at least 3½" to 4" shorter than the minimum necessary for an abdomino-anal resection.

Abdomino-anal Resection.

(1) With anal or perineal dissection (Sebrechts-Rayner operation.
(Babcock-Bacon operation.

In Sebrechts' operation as practised by Rayner (1935) the abdominal part proceeds as far as freeing of the rectum down to the anorectal ring and division of the inferior mesenteric vessels. The rectum and lower colon are then crowded into the bottom of the pelvis, the peritoneal floor of which is afterwards reconstituted, a gap remaining

in the middle through which the pelvic colon passes. The edges of this gap are sutured to the colon as high as possible. The abdomen is finally closed and the patient put in a tilted lithotomy position.

The rectum is washed out by an assistant to clear it of debris that has accumulated owing to the previous manipulations, and firmly packed with gauze. The anal orifice is closed with a purse string suture just above the mucocutaneous junction. A circular incision is then made at the junction itself and the mucous membrane dissected up as a cylinder, just as in Whitehead's operation for haemorrhoids, to a height of 1½"-2". Care is necessary to avoid button-holing the mucous membrane, the preliminary cleansing of the rectum having been undertaken in case of this accident. A cut is then made in the midline posteriorly just above the anorectal ring, which can be recognized by palpation, through the muscular wall of the rectum till the subperitoneal space of the pelvic cavity is entered, and communication with the previous field of operation is established. With the fingers in this space it is easy to extend the incision circularly round the bowel severing the rectum from the anal canal. The rectum and colon are then

drawn down through the anal sphincter, the point previously selected for the anal orifice noted, and the bowel divided there between clamps. A drain is introduced into the pelvis through a small stab incision to one side of the coccyx. The end of the colon is fixed to the perianal skin by a series of mattress sutures, the clamp removed, and exact apposition of mucosa and skin achieved by further stitches. It will be seen that though a slightly different technique is adopted to achieve it the nett result so far as the anastomosis is concerned is the same as that obtained by the Hochenegg pull through operation (see Fig. 22).

Rayner had performed this operation only 3 times, on each occasion using a preliminary transverse colostomy. There were no operative deaths and the functional result was good in 2 cases, but imperfect in the third. I have been unable to discover any reference to an original account of this operation by Sebrechts himself.

The Babcock operation was first described in 1932; since then the originator has modified his technique slightly and the following account is based on his latest description - Babcock (1947). The abdominal phase follows the lines of the

Sebrechts-Rayner except that Babcock prefers an oblique left inguinal incision, and at the conclusion of this stage does not attempt to suture the peritoneum of the pelvic floor. A metal drain is inserted down to the pelvis through the bottom end of the wound for suction drainage for 3 or 4 days after operation. It may be added that no preliminary transverse colostomy is used.

The patient is then placed in the lithotomy position, the rectum swabbed out and packed with gauze soaked in 3.5% Tr. Iodine. A midline incision is made through the posterior border of the anus, sphincters and pelvic floor to the right side of the coccyx, and deepened into the pelvis. The mobilised pelvic colon and rectum can then be felt. The rectum is divided circularly with scissors just above the sphincters and its upper edge caught with forceps as the division proceeds. Pulling on these forceps the levator muscle on either side is severed and the rectum separated from the lowest part of vagina or prostate in front if this has not been fully accomplished during the abdominal dissection. Finally the rectum and colon are delivered through the wound till the point selected for division projects 2" or so beyond the anal verge. Attention is now directed

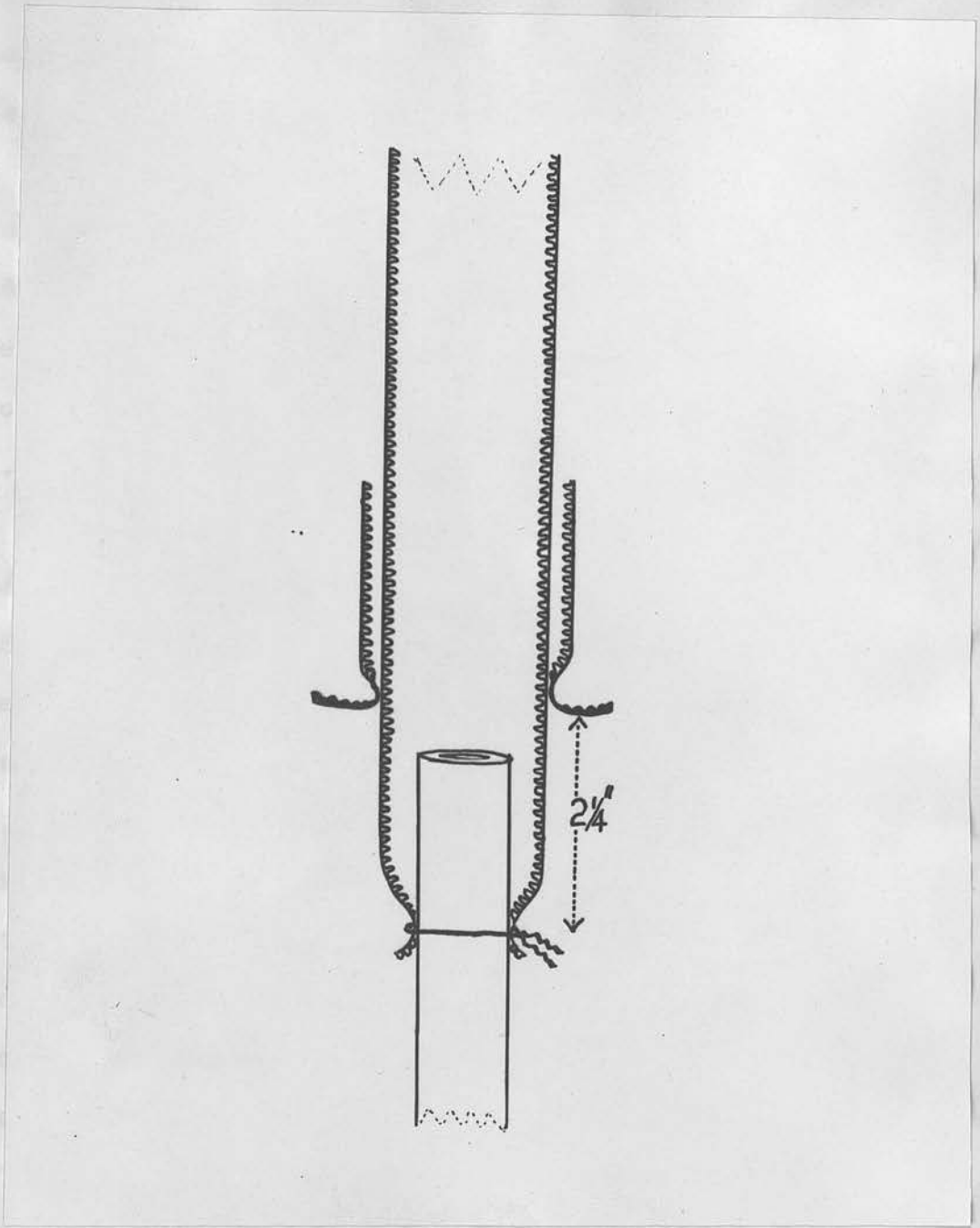


Fig. 37. Babcock's operation. State of affairs at completion with colon stump projecting through anus. Note that anorectal mucosa has been preserved.

to haemostasis in the pelvic cavity and the levator muscles and skin are then sutured in the midline, care being taken not to constrict the colon protruding at the anus. It should be just possible to introduce the index finger between the bowel and the suture pelvic floor. Dressings are applied. The projecting rectum and colon are then amputated 6 cms. distal to the skin margin of anus and a No.28 F rectal tube tied into the colon (see Fig.37). No drain now used for pelvic wound.

Six days after operation the rectal tube becomes loose and drops out of the bowel. Two or 3 days later if the perineal wound is healing well, the colostomy stump is trimmed flush with the anus with a clamp and diathermy or a wire snare. No anaesthetic is required for this manoeuvre. The edge of the colon eventually retracts inside the anal canal and unites with the edge of the anal mucosa according to Babcock.

The points on which Babcock lays stress are:-

(1) There is only one stage to the operation, no abdominal colostomy being necessary.

(2) The pelvic peritoneum is not sutured.

(3) The anal canal is not denuded of its mucosa.

(4) The colon is not sutured to the anal margin in any way, but just projects well beyond it.

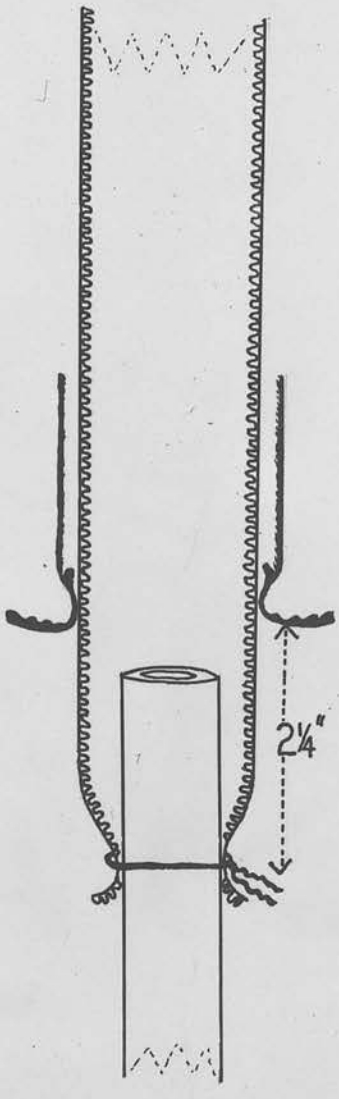


Fig. 38. Bacon's operation. State of affairs at completion with colon stump projecting through anus. Note that anorectal mucosa has been removed.

In Bacon's (1945) modification the essential difference is that the anal canal is denuded of its mucosa as in the Sebrechts-Rayner procedure, and as in that operation the sphincters are not divided but merely stretched. However the colon is not finally stitched to the anal skin but is allowed to project for 2½ inches or so as in Babcock's operation, with a rubber catheter tied into it (see Fig.38). It is clear from Babcock's (1947) remarks that there is a considerable risk of the colon being so compressed by the undivided sphincter, when its tone recovers after operation, that gangrene may ensue.

Babcock (1940) had 11 deaths in 52 cases submitted to his operation, which amounts to a mortality of 20%. In a series of 145 cases Bacon lost 8 or 5.5%. The only report of the ultimate survival rate after this operation that I have been able to discover is one made by Sénèque (1946) after a visit to Babcock's clinic; he states that the 3 year survivals were 58.6% and the 5 year survivals 50%, but does not indicate how many cases were followed up for these periods. Operation deaths were apparently excluded. As

regards functional results Bacon (1945) states that "The sphincter function following proctosigmoidectomy is not perfect nor that for which we strive, yet in approximately 80% of our cases continence is cited, and 95% of patients were able to carry out their daily occupations without inconvenience". The same author however adds that in 51 patients in whom he or Babcock transferred an abdominal colostomy to the perineum, the functional result was distinctly better than with the abdominal stoma, which suggests that the state of his proctosigmoidectomy cases may have been much the same as that of these sphincterless sacral colostomy patients. There is no mention of the incidence of fistulae or stenosis following proctosigmoidectomy.

(2) Without anal or perineal dissection. Maunsell operation(1892). Weir operation (1901).

In both these operations not only the anal sphincters but also the anal mucosa is preserved intact and no incision is made in the perineal or sacral region. In the Maunsell operation, after mobilisation of the sigmoid colon and rectum down to the anorectal ring and division of the inferior mesenteric vessels, the growth is intussuscepted into the rectum and through the anus drawing the colon

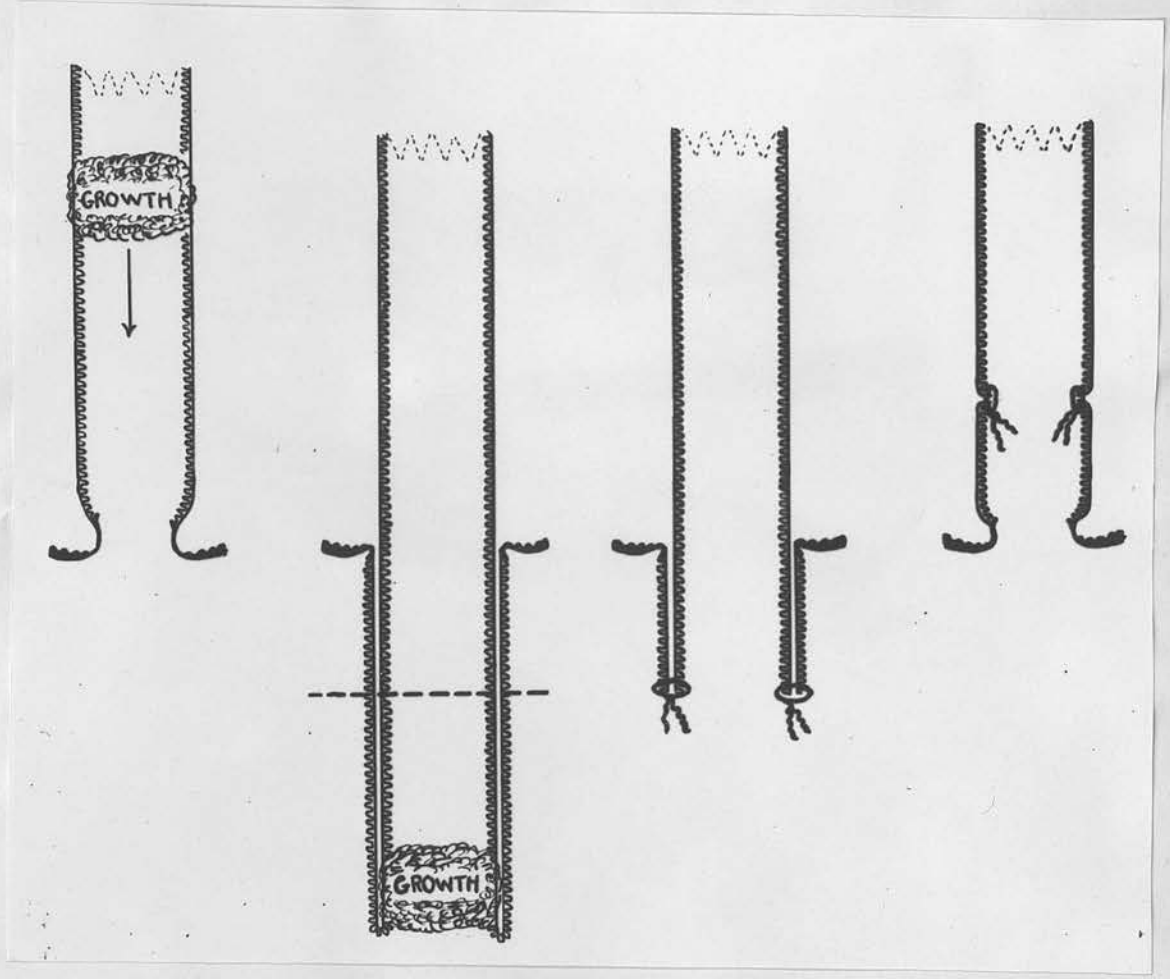


Fig. 39. Maunsell's operation.
Growth prolapsed through anus and projecting colorectal segment excised. Subsequent suture as in Hochenegg's invagination method.

after it as in Fig.39. The prolapsed colo-rectal segment is then amputated from below as in a Mikulicz rectosigmoidectomy for prolapse and the cut edges of colon and everted rectum sutured together as in that operation. Finally the anastomosis is replaced in the pelvic cavity through the anus.

In Weir's operation, which is a modification of Maunsell's, the difference lies in the method of excision of the part of rectum and colon to be removed. This is carried out exactly as in an abdominal resection, with the creation of an ano-rectal and sigmoid stump. Special care is taken to make the latter as long as possible. Continuity is restored by everting the remnant of rectum through the anus and drawing the lower end of the colon stump down through this, so that the cut edges of the two stumps can be united by suture as in Hochenegg's invagination method (see Fig.23).

Our main criticism of the Babcock-Bacon and Sebrechts-Rayner operations is that the division of the sphincters or removal of the anal mucosa, which is an essential part of them is bound to impair the functional results. This is borne out by the

report of Bacon (1945) as to the measure of continence enjoyed by his cases. There is no doubt however that though these patients are usually quite incontinent at first a degree of control is often developed after 12 or 18 months. In addition, there being no intrapelvic suture line in this operation, the patient in effect having a colostomy established at his anus, the risk of leakage and infection ought to be much diminished and there is no need for any preliminary or simultaneous transverse colostomy. It seems to us not unlikely however that necrosis of the long colon stump may occasionally occur, with sloughing extending inside the pelvis and resulting abscess formation or peritonitis. It is to be noted that 4 of Babcock's (1940) 11 operation deaths were due to peritonitis.

The Maunsell and Weir operations are more attractive from the physiological point of view, because in them the sphincters and anal mucosa are preserved intact. On the other hand when completed they leave the patient with a suture line in the bowel and the same anxiety as regards leakage and infection therefore arises as with an abdominal resection, and the necessity for a transverse colostomy must be considered.

Our personal experience of abdomino-anal resection has been confined to operations of the Weir type, a procedure which was elaborated quite independantly at St. Mark's Hospital without knowledge of its prior description. Invariably a preliminary transverse colostomy was established and for the resection itself the lithotomy-Trendelenburg position, which we consider ideal for these cases, was employed. In 21 cases there was one operative death, due to paralytic ileus. Quite half the cases developed strictures at the site of anastomosis, and these required frequent dilatation and occasionally proctotomy. The results as regards continence however were good, all surviving cases regaining full continence for faeces and flatus, but just as with low abdominal resections these patients complained at first of frequent bowel actions, usually one after every meal; in due course this gradually rectified itself.

Late Results after Resection Operations.

In dealing with individual operations the remote results reported by other surgeons have been mentioned in so far as they seemed valuable. It is appropriate that something should now be said of our own results.

We have records at St. Mark's Hospital of 89 cases treated by different forms of radical resection for carcinoma of the rectum and rectosigmoid. This figure includes 24 patients submitted to Hartmann's operation because, so far as removal of tissues is concerned, this procedure is really an abdominal resection, the only difference being that no attempt is made to restore continuity and the patient is left with a blind rectal stump and an iliac colostomy. Though some of the cases, particularly those submitted to abdomino-anal resection or Hartmann's operation, were treated several years ago, the majority have been operated on quite recently. Obviously no comprehensive statement of late results is yet possible, but it must be reported that local "recurrences" in the bowel have already been observed in a number of these cases. No less than 9 patients have developed further nodules of growth

PATHOLOGICAL DATA REGARDING CASES DEVELOPING FURTHER GROWTH

IN THE BOWEL AFTER RESECTION OPERATIONS.

	ORIGINAL OPERATIVE SPECIMEN.					SUBSEQUENT GROWTH.		
CASES	Nature of original operation.	Margin of clearance between growth and lower end of specimen	A, B or C Case according to Dukes' classification	Presence of venous spread	Presence of associated benign papillomata	Time of detection after operation	Exact Site	Suggested mechanism of formation
I	Hartmann's operation	1"	A	No	No	1 year & 3 months	Extreme upper end	Implantation metastasis
II (Fig.40)	"	1"	A	No	No	7 years	Just above ano-rectal ring	Fresh primary
III	"	$1\frac{1}{2}$"	B	No	Yes	4 months	Extreme upper end	Implantation metastasis
IV (Fig.41)	"	4"	C_1 (but only one gland involved)	No	Yes (one large villous papilloma	2 years	1" from upper end	Fresh primary
V (Fig.42)	"	2"	C_1	No	No	3 months	Midline posteriorly & upper end	Implantation metastasis
VI	Abdominal resection	1"	C_2	Yes	No	4 months	On suture line posteriorly.	Inadequate excision.
VII (Fig.43)	Abdomino-anal resection	$2\frac{1}{2}$"	C_I (one gland only involved)	No	No	2 years	On suture line posteriorly	Implantation metastasis
VIII (Fig.44)	Abdominal resection	$\frac{1}{4}$"	C_2	No	No	1 year	On suture line	Inadequate excision
IX (Fig.45)	Abdomino-anal resection	1"	C_I (one gland only involved.)	No	No	3 years	Anterior wall abutting on suture line	Implantation metastasis

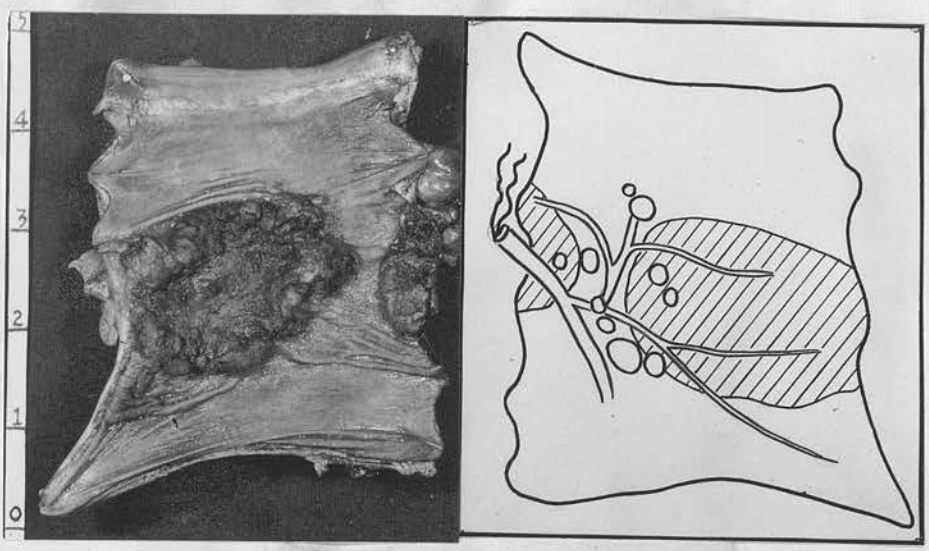
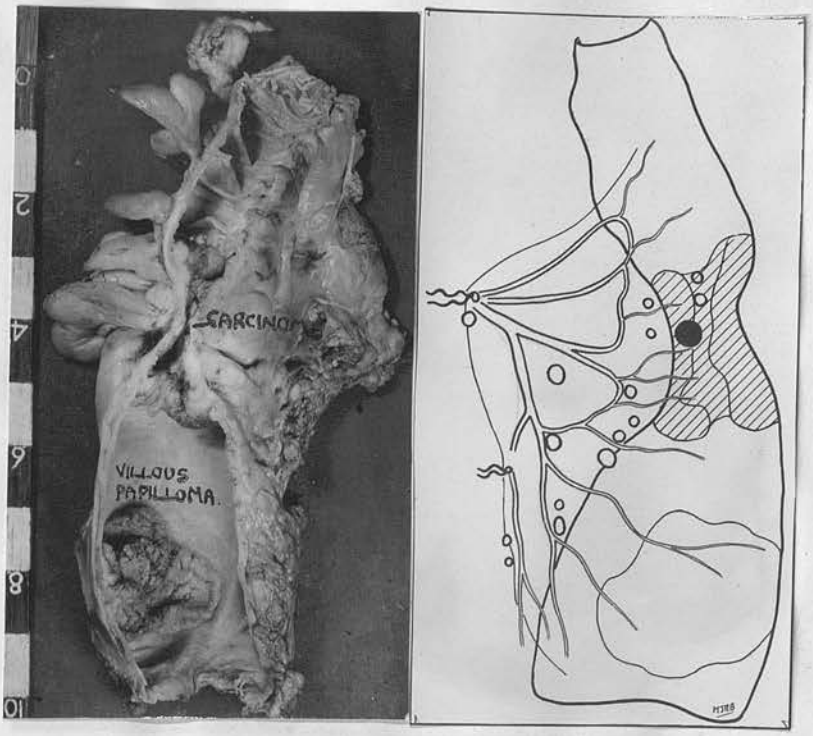


Fig. 40. Photograph and drawing of specimen of carcinoma recti obtained by Hartmann's operation in Case II, Table I; 7 years afterwards further growth appeared in lower part of rectal stump.

Specimen obtained by Hartmann's Operation.



Rectal stump removed 2 years later.

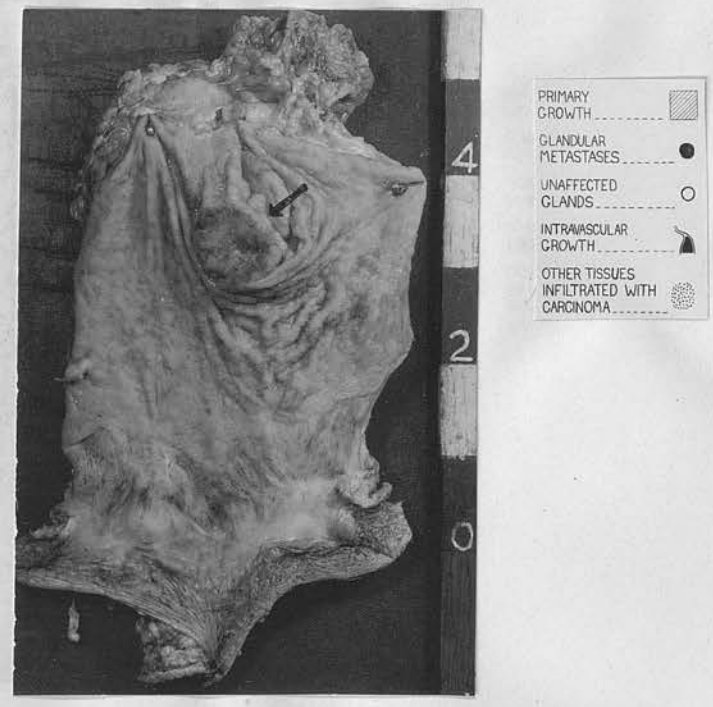
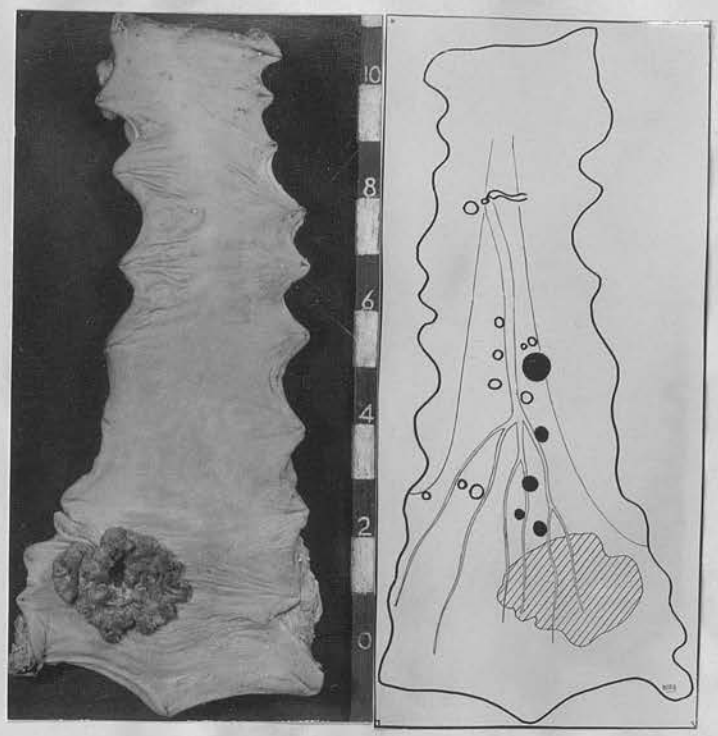


Fig. 41. Photograph and drawing of specimen of carcinoma of rectum obtained by Hartmann's operation, and of rectal stump containing further growth, removed 2 years later. (Case IV, Table I).

Specimen obtained by Hartmann's Operation.



Rectal stump removed 3 months later.

Fig. 42. Photograph and drawing of specimen of rectal carcinoma secured by Hartmann's operation, and of rectal stump, the seat of further growth, removed 3 months later. (Case V, Table I.)

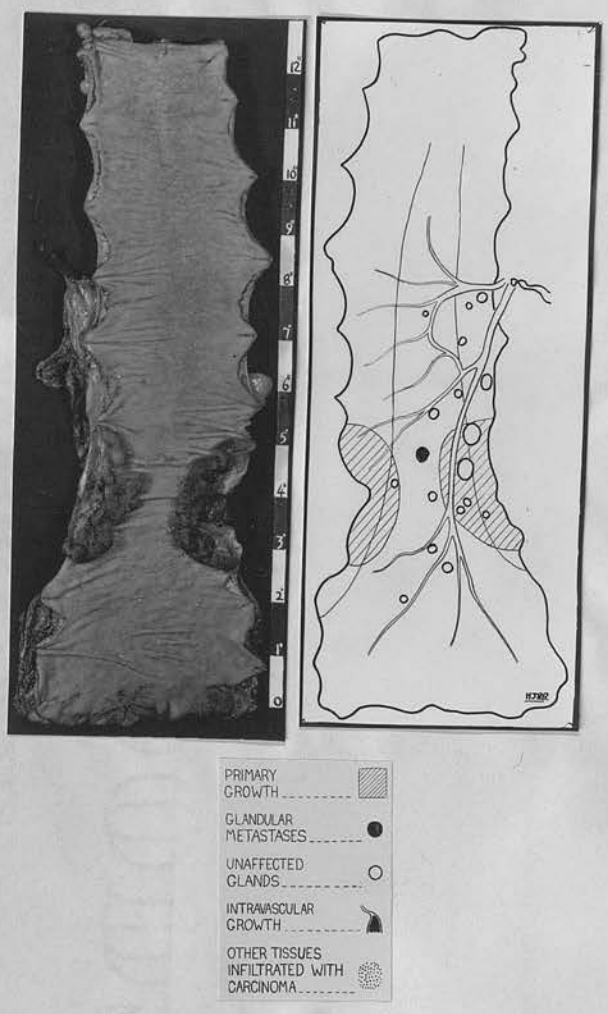


Fig. 43. Photograph and drawing of specimen of carcinoma of rectosigmoid obtained by abdomino-anal excision (Case VII, Table I). A deposit of growth appeared on posterior part of suture line in this patient 2 years later, and she died shortly afterwards.

Specimen obtained by Abdominal Resection.

Specimen removed by Combined Excision
1 year later.

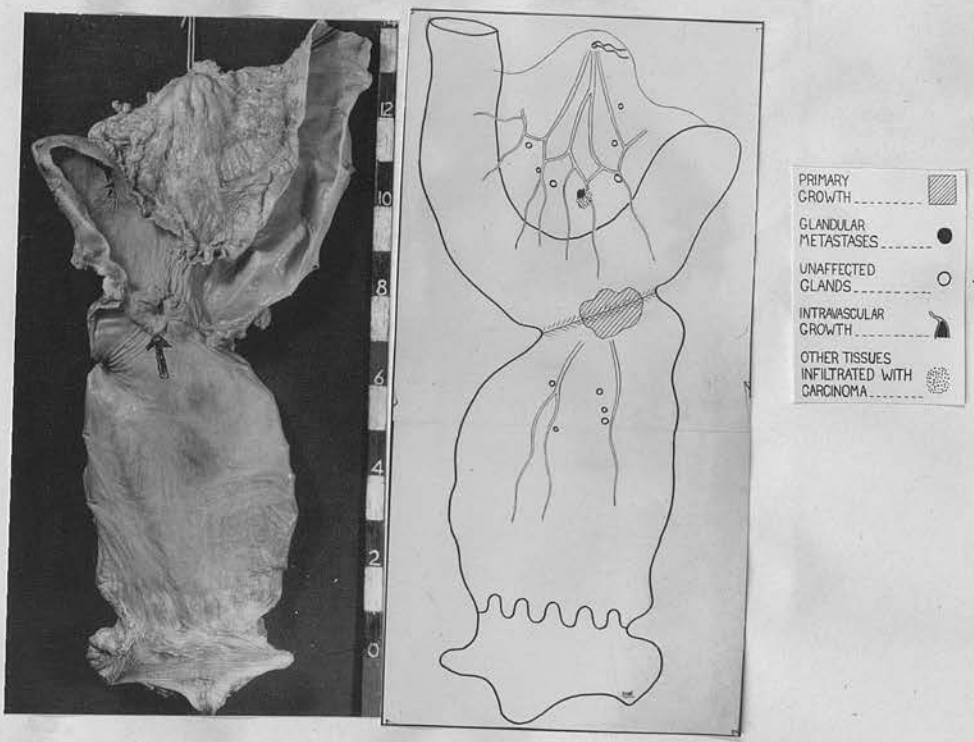
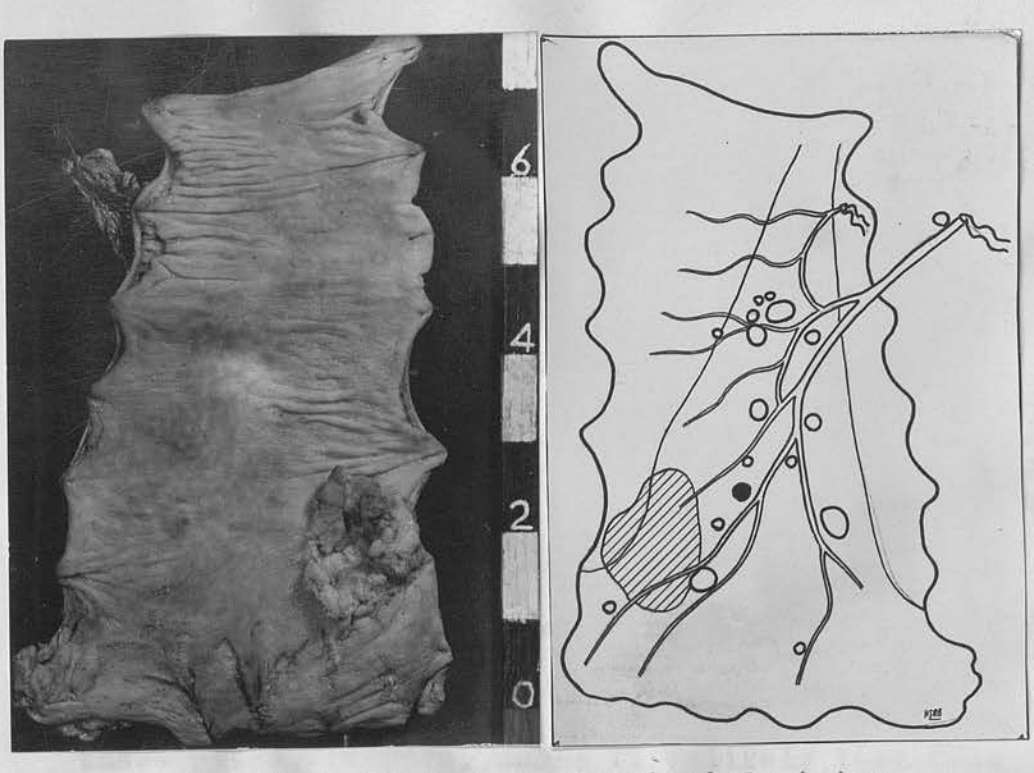


Fig. 44. Photograph and drawing of specimen of carcinoma recti obtained by abdominal resection, and of further growth in suture line removed by combined excision 1 year later (Case VIII, Table I).

Specimen obtained by Abdomino-anal Resection.



Specimen removed by Combined Excision 3 years later.

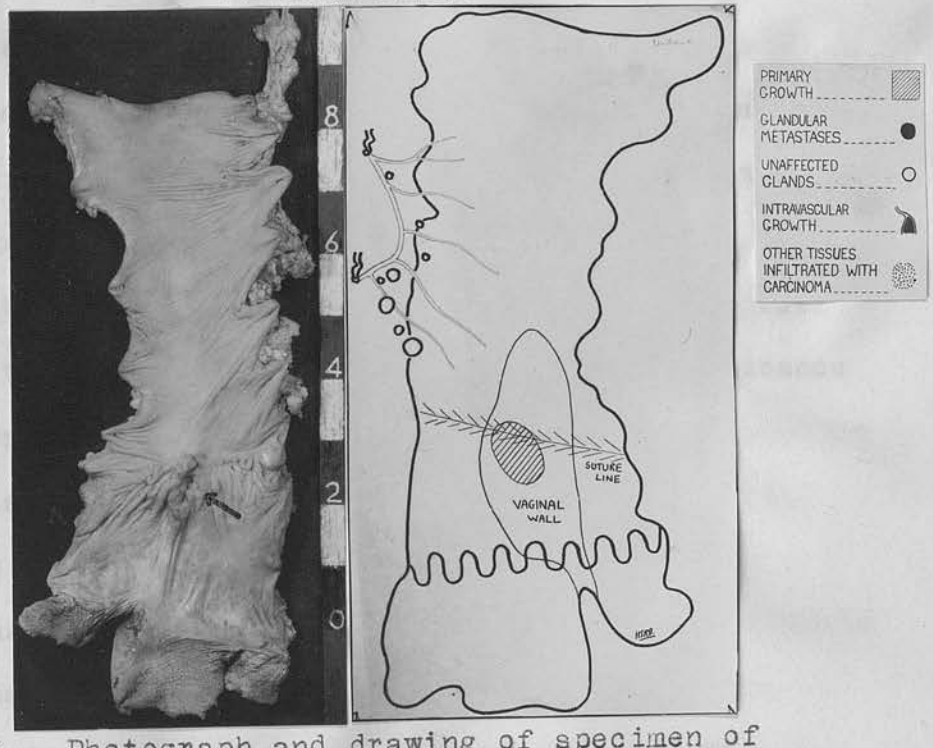


Fig. 45. Photograph and drawing of specimen of carcinoma recti obtained by abdomino-anal resection and of further growth in vicinity of suture line removed by combined excision 3 years later (Case IX, Table I).

either in the rectal stump or in the vicinity of the anastomosis, and we must anticipate seeing more of these in the next year or so. In seeking an explanation of these unfortunate results 3 possibilities seem worthy of consideration:-

1. Inadequate Excision. The first explanation that suggests itself is of course that the growth was incompletely removed in the first instance. Examination of the operative specimens obtained in these cases, however, makes it unlikely that this was often the reason. The relevant pathological data regarding these specimens and the growths that developed subsequently are recorded in Table I; in addition 6 of these specimens are illustrated in Figs. 40 - 45.

It will be admitted at once that in Case VIII where there was an insufficient margin of clearance between the growth and the lower end of the specimen and also extensive lymphatic spread (see Fig.44), and in Case VI where the lymphatic and venous systems were both heavily involved the most probable explanation of the development of growth on the suture line was inadequate excision. But the specimens in all the other cases show a good margin of clearance of the primary growth, no

demonstrable venous spread, and at most only minimal involvement of the lymphatic system. According to our pathological criteria these would appear eminently satisfactory specimens offering an excellent prospect of complete cure. It is difficult to see how the later manifestations of growth in these cases could have been due to inadequate removal unless one is prepared to postulate the existence of pathways of spread not disclosed in our dissected specimens. One is reluctant to do this because the information derived from these pathological preparations has proved a most reliable index in the past to the prognosis after operation, as the writings of Dukes (1943) and Gabriel (1945) testify.

2. The Development of a Fresh Primary Carcinoma. There is much to be said for the view of Lockhart-Mummery and Dukes (1928) that the mucosa of the rectum and colon in cases suffering from malignant disease of these organs is in a diffusely abnormal condition predisposing it to the occurrence of epithelial hyperplasia. This is shown firstly by the frequent presence of multiple benign, but potentially malignant, polyps in the mucous membrane above and below such carcinomata - in 408 or 27.20%

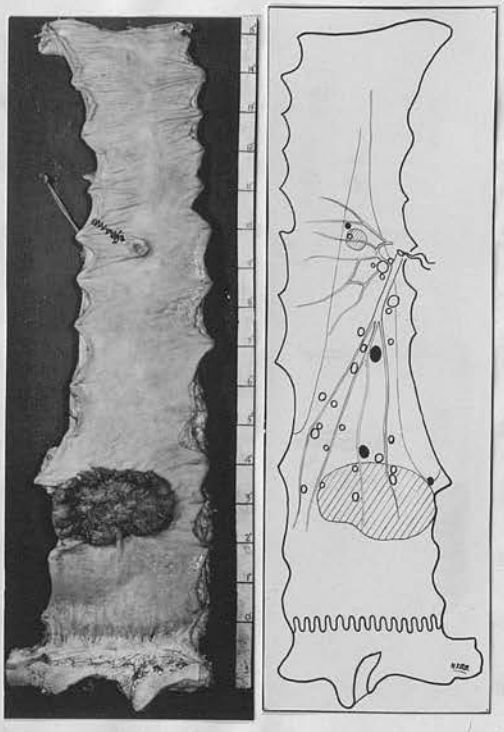


Fig. 46. Photograph and drawing of double carcinoma of rectum and colon removed by combined excision. Note that growth B is very much more recent than A.

of our 1500 combined excision specimens, as contrasted with 10% in the colon and rectum of ordinary autopsy room bodies (Dukes 1926). It is also indicated by the fact that carcinomata of the rectum or colon are occasionally double or treble - in 47 or 3.13% of our 1500 combined excision specimens. In the latter cases both growths are usually in a similar stage of development and have apparently arisen more or less simultaneously, but sometimes one is much smaller and presumably more recent than the other as in Fig. 46. It is easy to see how the chronology and location of double growths might be such that one could be removed by a radical operation before the other has developed; the latter would then appear in the remaining portion of rectum or colon at a later date, as in the cases observed by Norbury (1930), Lockhart-Mummery (1930), Westhues (1934), Finsterer (1941), Mayo & Schlicke (1942) and David and Gilchrist (1947).

It is possible that some of our apparent recurrences after resections might really be second primary growths. This would seem the most reasonable explanation in Case II (see Fig.40) where the interval of 7 years between the original operation

and the subsequent manifestation of growth in the rectal stump makes any continuation of the initial tumour most unlikely. It will be noted also that the later carcinoma arose in apparently intact mucosa just above the anorectal ring and well away from the upper edge of the stump where one might have expected any recurrence to develop. For this latter reason one might also regard the growth in the rectal remnant of Case IV as a second carcinoma (see Fig. 41). In the other cases, where the growth that arose subsequently appeared usually much sooner and invariably in relation to the suture line or the cut edge of the rectal stump, the theory of a second primary carcinoma is much less plausible, but in this connection the work of Deelman (1921-22) should perhaps be mentioned. He showed in animals that once an epithelial surface has been prepared by the repeated application of a carcinogen, the application of trauma to the treated area might result in the sudden development of a carcinoma at the point traumatised. It is conceivable that in carcinoma recti cases submitted to resection procedures the operative trauma might act in the same way on their abnormal rectal mucosa and precipitate the onset of another carcinoma.

It must be conceded that the risk of a second primary carcinoma arising after a resection operation is probably greater than after an ordinary combined excision because of the shorter piece of bowel with its potentially malignant mucosa removed by the former. The average length of our 65 restorative resection specimens was only 9.3" as contrasted with 18.9" for the series of 1500 combined excisions (though the amount of tissue of the upward zone of lymphatic extension was approximately the same in the two types of specimen). Further, as the incidence of carcinoma in the rectum and distal part of the sigmoid colon is maximal in the rectal ampulla, as Fig. 15 shows, it is clearly the retention of the rectal stump in resection operations that constitutes the greatest danger, in this respect. The greater length of sigmoid colon preserved is not such a serious drawback because the tendency for carcinomata to develop here is very much less.

To offset this disadvantage however the rectal stump - and, for that matter, almost the entire remaining portion of sigmoid colon - is readily accessible to examination by the sigmoidoscope, by means of which residual or freshly developing polypi may be removed by diathermy as required, thus possibly anticipating the genesis of a further

carcinoma. After resection operations the arrangements for following up the cases are especially important and should provide not merely postal information but facilities for sigmoidoscopy at short intervals.

3. The Occurrence of Metastases by Implantation.

According to Willis (1934) it is only in connection with tumours of the urinary tract that intralumenary dissemination of neoplastic cells and their implantation on the adjoining mucosa or wound surfaces at operation can be regarded as an established mode of spread. The case for this method of extension in the gastro-intestinal system is considered by him to be unproven. But more recently Muir (1938) has again advanced this hypothesis to account for recurrence in the ano-rectal stump after Hartmann's operation.
Certainly some of these recurrences which we have encountered after resection would seem to be very convincingly explained on the assumption that they were implantation metastases.

It will be noted that with the exception of Cases II and IV all our recurrences arose where a raw surface had been created by the operation, that is at the upper end of the rectal stump in Hartmann's operation or at the suture line in

restorative resections. Particularly striking in this respect was Case V, where the anorectal stump was incised at the conclusion of the operation in order to divide the sphincters and promote better drainage of the pelvic cavity; the recurrence in this patient developed on the wound resulting from this incision and at the upper end of the stump (see Fig. 42). Finally it should be mentioned that Case VIII was complicated by the occurrence of a nodule of growth (confirmed by biopsy) in the paramedian wound in the anterior abdominal wall. Whatever may have been the explanation of the deposit in the region of his bowel anastomosis this recurrence in the abdominal parietes can only have been due to implantation, which demonstrates beyond doubt that this form of spread is possible with carcinoma of the rectum.

It would seem therefore that there is a real danger of cancer cells, present in the lumen of the bowel below a rectal carcinoma, becoming engrafted on any raw surface with which they are allowed to come in contact. Hitherto, little opportunity has been afforded for the formation of implantation secondaries in this way, because the operations generally employed have been combined excisions or similar amputative procedures in which the entire

rectum down to the anus (which has been securely closed beforehand by a purse-string suture) has been removed. There is presumably no upward passage of carcinoma cells in the lumen of the bowel against the faecal stream to give rise to deposits in the region of the iliac colostomy after such operations. But with resections of either Hartmann's or restorative type there is obviously considerable scope for the production of metastases by implantation. It may be argued that if this form of spread occurs with rectal carcinoma it ought by analogy to take place with growths of the colon and stomach, in the treatment of which resection with anastomosis has long been the accepted surgical method, and yet suture line deposits following these operations have not been recorded. This is true, but it certainly does not mean that they do not occur. Most patients who develop recurrence after operation for gastric or colon carcinoma die either at home or in hospitals for incurable cases, and as the cause of their death is evident they are seldom submitted to necropsy, so that our knowledge of the extent and nature of the recurrences is very imperfect.

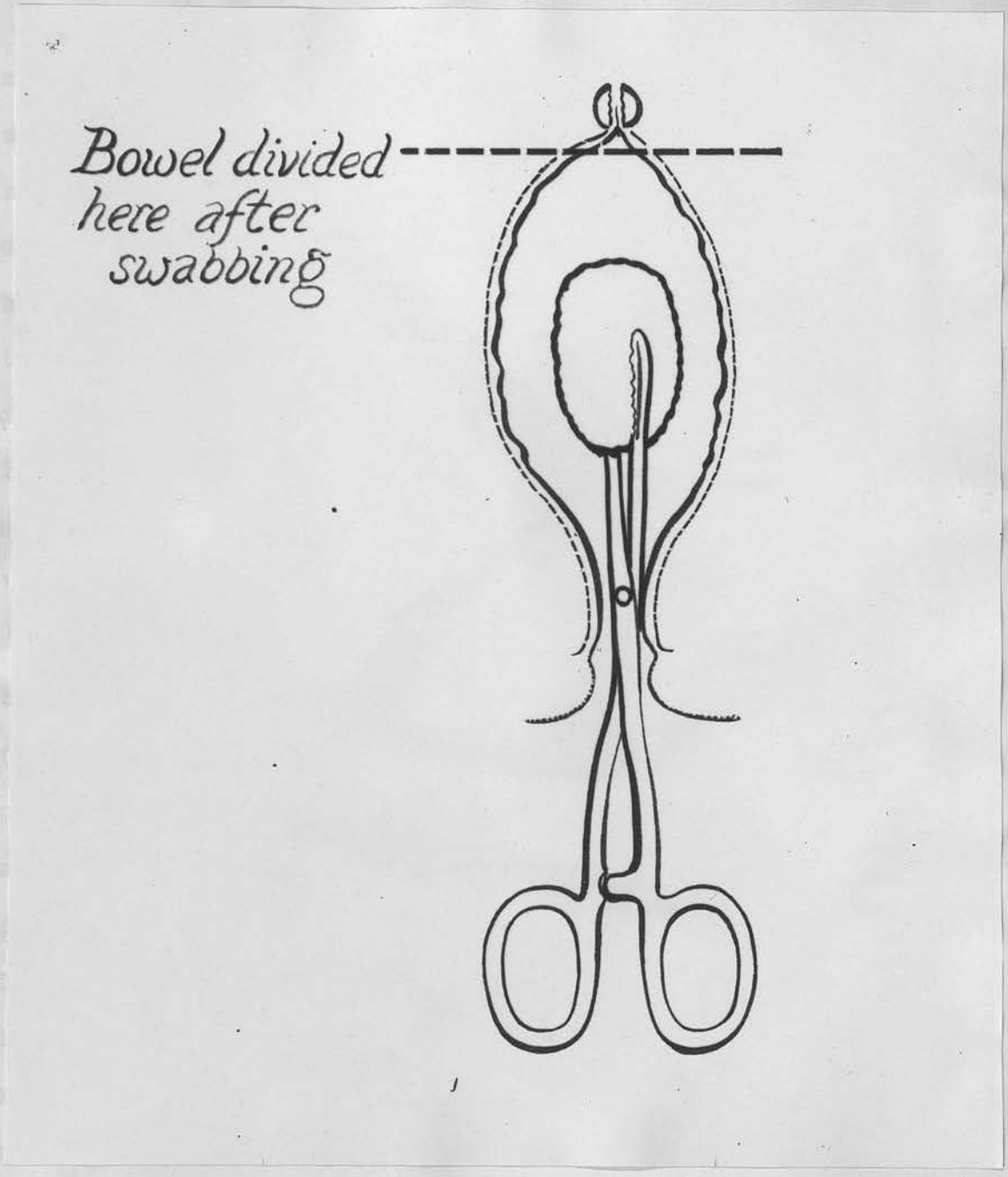


Fig. 47. Diagram showing method of clamping rectum below growth and swabbing with perchloride of mercury to kill any loose carcinoma cells in lumen before dividing bowel.

To guard against this risk of metastases arising by implantation of cancer cells in the course of resection operations for rectal and rectosigmoid cancer, we now always take precautions at St. Mark's Hospital similar to those advised by Thomson-Walker (1934) in operating on bladder tumours. The principle has been to try and destroy any loose malignant cells present in the lumen of the bowel below the growth by the application of a strong protoplasmic poison such as 1/1000 solution of perchloride of mercury, surgical spirit or 4% silver nitrate solution immediately before the rectum is divided. To do this satisfactorily the use of the lithotomy-Trendelenburg position is essential because it alone permits of swabbing or irrigation being easily carried out per anum in the course of an abdominal dissection. The procedure is to apply a crushing clamp 1" inferior to the growth to prevent the descent of any further faecal matter or discharge which might contain cancer cells. An assistant then cleanses the lower rectum from below, and when the bowel is thoroughly clean its lumen is treated by swabbing or irrigation with the perchloride of mercury solution for 5 minutes. Finally the rectum is divided by the surgeon at least ¼" distal to the clamp as in Fig. 47.

Goetze (1944) has also observed recurrences in the anastomosis after resections for rectal carcinoma. Wangansteen (1945) states that 5 of his 22 patients who survived abdominal resection for carcinoma of the rectal ampulla developed local recurrences soon after operation. It is not clear from his account where precisely these recurrences were located, but apparently some of them were situated in the bowel itself. He attributes them largely to failure to remove involved levator muscles, and both he and Goetze take the view that they are only likely to occur with low growths. Our own experience does not bear them out on this point, however, because, with one exception, the primary growths in our 9 cases which developed further local growths lay above the level of the peritoneal reflection.

Whatever the explanation of these unfortunate results they constitute a most disturbing development in connection with resection operations. Despite the strong case that can be argued on pathological and anatomical grounds for the employment of these operations in a large percentage of rectal and rectosigmoid growths, and the gratifying immediate results that can be obtained by them, it

is clear that their place is very insecure. The only justifiable attitude to take towards restorative resections at the present time is that they are still very much on trial and that the evidence against them is accumulating.

SUMMARY:

1. In this thesis an attempt has been made to ascertain how far sphincter conservation and restoration of continuity can be reconciled with the requirements of radical surgery in the treatment of carcinoma of the rectum and rectosigmoid, and to decide which are the best technical methods of achieving this end.

2. A study of 1500 combined excision specimens has disclosed the following facts:-

(a) In approximately 40% of the combined excision cases the growth was situated in the anal canal or lower 1/3rd of the rectum and the removal of the anal sphincters and related levator muscles was essential for radical treatment.

(b) In the remaining 60%, however, in which the growth lay in the upper 2/3rds of the rectum or in the rectosigmoid, it was not apparent that the sacrifice of the sphincter apparatus had in any way increased the prospects of eradication of the disease. It seemed that preservation of the anus and rectum from a level 1" below the lower margin

of the primary tumour mass would not have adversely affected the chances of ultimate cure. The rare occurrence of retrograde venous and lymphatic extension below this level is not denied, but such cases, by reason of their wide spread in other directions, must be regarded as incurable by any operation.

(c) The most important avenue of extension of carcinoma of the rectum and rectosigmoid is by the upgoing lymphatics and veins accompanying the superior haemorrhoidal and inferior mesenteric arteries. No operation for these conditions can be considered adequate unless it provides for removal of these vessels to a high level. Spread to the sigmoid paracolic glands only occurs when the growth arises in the rectosigmoid and they lie in sequence between it and the inferior mesenteric glands. Consequently all but the basal and possibly the lowest part of the sigmoid mesocolon and attached colon may always be safely preserved.

3. An examination of the arrangement of the blood vessels to the rectum and distal half of the colon in 75 necropsy room bodies, supplemented by observations on living patients at operation, has established the following points:-

(a) The left colic and first sigmoid arteries generally spring conjointly from the inferior mesenteric trunk opposite the bifurcation of the abdominal aorta; in a combined excision the ligature on the inferior mesenteric vessels is generally placed immediately below this point.

(b) With the main ligature so sited, it is, however, possible in practically every case to prepare a sufficiently long well vascularized piece of sigmoid colon to permit of end-to-end union with an anorectal stump after resection. One method of preparation provides for a direct blood supply to the end of the sigmoid stump through the first sigmoid branch; if this stump should not be long enough additional length may be secured by preserving the intersigmoid marginal artery and colon for 2 or 3" below the first sigmoid, or by severing the latter branch and relying on the descending division of the left colic artery. Our preference is for the latter method whenever possible.

(c) When an abdomino-anal "pull through" type of operation is contemplated a very much longer

sigmoid stump is required. In our experience this can also be provided by a combination of methods in the great majority of cases, though not in all.

(d) When the entire sigmoid colon has to be sacrificed, as for example in some cases of double carcinoma, restoration of continuity may still be possible by resecting up to the splenic flexure or middle of the transverse colon and swinging down the remainder of this to the anorectal stump or anus. Occasionally a graft taken from the lower ileum with its blood supply intact may be useful in this type of case.

(e) The blood supply to the anorectal stump after resection with division of the superior, and often the middle, haemorrhoidal vessels is surprisingly abundant. It would appear to be derived not only from the inferior haemorrhoidal arteries but also from numerous unnamed branches in the levator ani muscles.

4. The highest point at which the superior haemorrhoidal or inferior mesenteric vessels can be tied through a sacral approach is usually 3 or 4" lower than the site generally chosen for this

ligature in a combined excision. Sacral resections are therefore condemned as pathologically inadequate, and the recorded results support this condemnation.

5. An abdominal phase, to permit of high division of the inferior mesenteric vessels and proper preparation of the colon stump, is an essential part of any radical resection operation. The steps of the abdominal dissection are described in detail. The operation may be carried out entirely through the abdomen or completed as an abdomino-sacral or abdomino-anal resection.

6. Our experience has been chiefly with abdominal resection and it has been found possible to remove nearly all growths, that are suitable for resection, by this method. An "open" suture technique has been used for making the anastomosis in the bowel. We have not been able to reach any firm conclusion as to the advantage of establishing a preliminary or simultaneous transverse colostomy. Post-operative septic complications and fistulae have not been common. There have been 5 hospital deaths in 45 cases. The functional results have been uniformly excellent.

7. For some low growths in the middle 1/3rd of the rectum in individuals with narrow pelves an abdomino-sacral or abdomino-anal technique of resection may be advisable. We have had no personal experience of the former, but have used abdomino-anal resection of Maunsell-Weir type in 21 cases with one operative death. All the survivors possessed good rectal function, but troublesome stenosis at the suture line was a frequent sequel.

8. Most of our resection operations have been performed recently and no full account of the late results is yet possible. But in a few cases further growth has appeared in the region of the anastomosis in the bowel or in the rectal stump. It is suggested that this may have been due to:-

(a) incomplete removal at the original operation, (b) the development of a fresh primary carcinoma, or (c) the occurrence of metastases by implantation. The latter two seem the more likely explanations, and measures calculated to minimise these dangers are described.

9. In view of these unfavourable results an optimistic assessment of the value of resection

procedures in the treatment of rectal or recto-sigmoid cancer is not at the present stage justified.

I wish to express my indebtedness to my colleagues at St. Mark's Hospital, and particularly to Mr. C. Naunton Morgan and Mr. O.V. Lloyd-Davies, for allowing me to analyse their cases for the purpose of this paper; to Dr. Cuthbert Dukes for placing at my disposal his unique collection of pathological records at St. Mark's Hospital; to Mr. H.J.R. Bussey, B.Sc., senior technical assistant in the Cancer Research Department of St. Mark's Hospital for preparing all the photographs and diagrams; to Professor W.D. Newcomb for permission to investigate the anatomy of the blood vessels to the colon and rectum in the necropsy room material of his department at St. Mary's Hospital; to Mr. L. Field-Marchant for executing the drawings of operative procedure; and to Miss P.M. Cole for secretarial assistance.

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