

THE LYMPHATICS OF THE COLON.

WITH SPECIAL REFERENCE TO THE OPERATIVE TREATMENT OF CANCER OF
THE COLON.

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DURING the last four years we have been engaged on a research on the lymphatics of the alimentary canal, preparing for the purpose a large number of specimens injected by Gerota's method. Our material was drawn from subjects of all ages—chiefly children and young adults—as, except in the case of the appendix, fetal specimens are not very satisfactory. Previous work on the lymphatics of the colon had not shown the position of the primary glands and had done no more than furnish vague statements that the lymphatics ran with the blood-vessels. In April, 1907, our observations on the lymphatics of the cæcum and appendix were published,¹ and in March, 1909, we gave an account of the vessels and glands of the colon.² In these papers we indicated for each part of the large intestine the extent of the operation which the anatomical facts demanded. Recent papers on the subject appear either to ignore the necessity of complete removal of lymphatic areas or to recommend operations based on a faulty conception of the anatomy of the lymphatics. The methods of operation for cancer of the colon outlined in the following pages have been practised without any special difficulty and without mortality.

The Necessity for Removing Lymphatic Glands in Cases of Cancer of the Colon.—No operation for malignant disease can be considered complete without the removal of lymphatic

glands. In the colon, as elsewhere, cancer gives rise to secondary gland disease, though it is accepted that this gland invasion may be late or even absent (Treves,³ de Bovis⁴). In many cases it is overshadowed by secondary visceral disease. The glands may be enlarged from inflammatory disease without malignant infiltration (Bilton Pollard⁵). H. S. Clogg found cancerous deposits in the lymphatic glands in 28 out of 45 cases of malignant disease of the cæcum and colon.⁶ Recurrences are known to be frequent after colectomy (de Bovis, Clogg); some no doubt are due to visceral disease unmasked at the time of operation: other recurrences are indubitably glandular. It is impossible for the surgeon to determine at the time of operation whether a growth in the colon has given rise to secondary gland infection or not. To minimize as far as possible the likelihood of recurrence, it is necessary to remove with the primary growth those glands which are likely to have become affected. The primary glands—those receiving direct vessels from the gut—will be the first to become diseased by cancerous emboli carried to them along the lymphatic vessels from the primary growth, and any one primary gland is just as likely to become affected as another, whatever may be their comparative position with regard to the colon. In those portions of the colon supplied by long arterial arcades the paracolic glands at some little distance from the seat of the disease may become affected; this applies in particular to the transverse colon and to a lesser extent to the ascending and descending colon. The lymphatic vessels which emerge opposite the centre of the arcade have to travel in one direction or the other for a considerable distance parallel to the gut before they reach an arterial trunk along which they can pass towards the main groups. These vessels enter some paracolic gland on their way, while a vessel issuing opposite the trunk of one of the larger colic arteries would, after the same length of course, have reached an intermediate or even a main group gland. It is evidently necessary to remove the paracolic glands for some little distance on each side of the primary growth, and this necessitates excision of a

considerable length of gut; in particular this applies to the transverse colon.

The ideal operation consists in removing a considerable length of gut on each side of the growth, the primary glands, together with the vessels running to them from the gut, and the tissues in which these vessels lie—*i.e.*, the so-called "lymphatic area."

In some situations it is impossible to remove the whole of the lymphatic area—*e.g.*, at the splenic flexure. In removing the primary glands many of the secondary glands will be included, but the secondary glandular system of any part of the colon is too extensive to permit excision. In certain cases it may be found that although the local conditions are favorable for excision, glandular hypertrophy has extended beyond the primary glands and has involved the secondary glands. If the secondary glands are certainly malignant it would appear to be useless to proceed with the operation, except as a palliative measure. The difficulty of determining malignancy in any given enlarged gland must, however, be borne in mind, and where there is the least doubt the growth with the primary glands should be excised in the hope that the enlargement of the remaining glands may be due to absorption from the ulcerated surface in the bowel, and not to malignant infiltration. That is to say, in every case in which the local and general conditions are favorable, the growth with the corresponding lymphatic area, or as much of it as is possible, should be excised apart altogether from the presence or absence of enlargement of lymphatic glands.

The Lymphatics of the Large Intestine.—The lymphatic glands of the large intestine (Fig. 1) are scattered along the course of the blood-vessels and may be described in chains corresponding to these vessels, *viz.*: the ileocolic chain, the middle colic chain, the left colic chain, and the inferior mesenteric chain. In each chain, at certain points the glands tend to form groups which owing to the presence of scattered

glands between them, are not sharply defined from each other; it is convenient for purposes of reference to name them, epicolic, paracolic, intermediate, and main groups.

The *epicolic glands* lie on the intestinal wall, often in the bases of the appendices epiploicæ, and are most numerous on the sigmoid flexure. They are small and unimportant and will not be mentioned in the description of the various chains.

The *paracolic glands* lie along the gut on the vascular arcades and the short straight terminal vessels proceeding from the arcades.

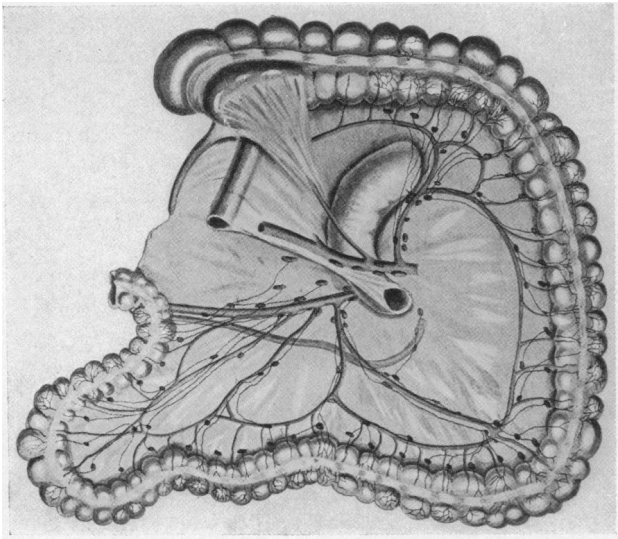
The *intermediate glands* are situated about midway between the arcades and the origins of the colic and sigmoid vessels.

The *main group glands* surround the stems of the vessels near their origin.

The *ileocolic chain* (Fig. 2) drains the lower end of the ileum, the cæcum and appendix, and the greater part of the ascending colon. Its paracolic glands lie along the inner side of the ascending colon (right juxtacolic glands), in the ileocolic fold (anterior ileocolic glands), and behind the ileocolic junction (posterior ileocolic glands). The intermediate glands lie on and above the point of division of the ileocolic artery into its various branches. The main group lies on the upper part of the artery and therefore partly in front of the duodenum. The scanty chain of glands lying on the right colic artery joins the main group of the ileocolic chain. The vessels from the ascending colon, cæcum and appendix, and terminal part of the ileum are not all intercepted by the paracolic glands; many proceed to the intermediate glands and a considerable number to the main group. Meso-appendicular glands are merely prolapsed members of the paracolic or intermediate groups, and their presence or absence is of no importance. There is no communication between the ovarian lymphatics and a meso-appendicular gland.

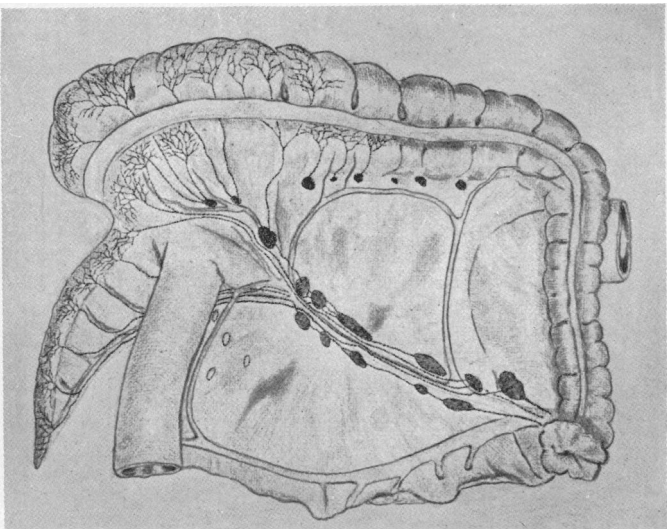
THE OPERATION FOR MALIGNANT DISEASE OF THE CÆCUM, AND LOWER PART OF THE ASCENDING COLON (Fig. 3).—In cases for radical treatment the operation necessitated

FIG. 1.



The lymphatics of the colon. (Proc. Roy. Soc. of Medicine.)

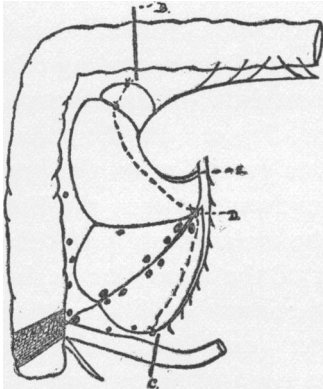
FIG. 2.



Lymphatics of the caecum and appendix. Anterior view.
(Lancet, Apr. 27, 1907.)

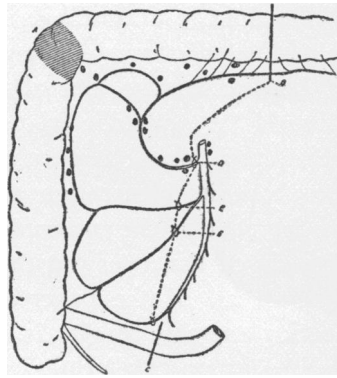
by the arrangement of the lymphatics is, viz.: After exposing the field of operation the lower border of the third part of the duodenum is defined. The peritoneum over this is divided and the ileocolic vessels are found. The fatty tissue surrounding the vessels which will contain the uppermost gland of the ileocolic chain is stripped downwards with gauze, care being taken not to wound the duodenum. The artery and vein are ligatured and divided close to the superior mesenteric artery. It is well at this stage to select the point on the transverse

FIG. 3.



Excision of growth in the caecum. *A*, growth; *B*, line of section of transverse colon; *C*, line of section of ileum; *D*, point of ligature of ileocolic artery; *E*, middle colic artery.

FIG. 4.



Excision of growth at the hepatic flexure. *A*, growth; *B*, line of section of transverse colon; *C*, line of section of ileum; *D*, point of ligature of middle colic artery; *E*, point of ligature of right colic artery; *F*, point of ligature of ileocolic artery.

colon where the gut shall be divided. The transverse mesocolon is then divided up to the selected point, some branches of the middle colic artery being secured. The middle colic artery itself is carefully preserved. If the right colic artery has a separate origin from the superior mesenteric it will need ligature. The peritoneum of the mesentery is then divided in an oblique line downwards to the ileum. The ileocolic and right colic vessels, with the accompanying chain of glands, the fatty tissue and the overlying peritoneum, are then stripped downwards to the ileum and caecum and outwards to the colon. The ureter and spermatic vessels are encountered and

must be avoided. The cæcum is then lifted up and the peritoneal reflection to the outer side of the colon is divided. The cæcum and appendix, the whole of the ascending colon, and the terminal portion of the ileum, with the ileocolic and right colic vessels and the lymphatic chain, can then be withdrawn from the abdomen, only remaining attached by the continuity of the intestine. The colon is divided at the previously selected point and the ileum about six inches from the valve. The operation is terminated by an ileocolostomy to the transverse colon, or—as was necessary in one of our cases—to the sigmoid colon.

The *Middle Colic Chain* drains the area of distribution of the middle colic artery—the upper part of the ascending colon, the hepatic flexure and about two-thirds of the transverse colon. The paracolic glands are disposed in the manner already mentioned; the intermediate group lies on the artery just above its bifurcation about midway between the bowel and the root of the mesocolon: the main group is placed on the stem of the artery at the root of the mesocolon in front of the head of the pancreas, sometimes blending with the superior mesenteric glands. Direct vessels reach the intermediate group in all cases and the main group in many, but only from the hepatic flexure, the upper part of the ascending colon and the right end of the transverse colon. The vessels from the central portion of the transverse colon are all intercepted by the paracolic glands.

OPERATION FOR GROWTHS IN THE NEIGHBORHOOD OF THE HEPATIC FLEXURE (Fig. 4).—(Growth in this situation are not uncommon but are rarely removable as they quickly become adherent and fixed to neighboring structures—pancreas, duodenum, etc. To remove the “lymphatic area” it is necessary to tie the middle colic artery at its origin from the superior mesenteric and to remove the mesocolon from this point up to the bowel. By this step the whole of the middle colic chain of glands is secured. Ligature of the artery devitalizes so much of the ascending colon—particularly in those cases where the right colic artery has origin from the

middle colic—that it is necessary to remove the whole of the ascending colon, with the cæcum and terminal six inches of the ileum, the growth at the hepatic flexure and about half the transverse colon, completing the operation by a lateral anastomosis between the ileum and the transverse colon.

The Left Colic Chain.—The paracolic glands lie in the usual situation. The intermediate group is scattered, but the majority of the glands lie on the artery just above the point where it is crossed by the inferior mesenteric vein, in front of the inner border of the kidney. The main group is divided: one part lies on the left colic trunk close to its origin, the other part on the curved upper end of the inferior mesenteric vein, and is continuous with the glands about the head of the pancreas (superior mesenteric and lumbar). Direct vessels from the splenic flexure reached the intermediate group in 4 out of 14 of our specimens, and from the descending colon in 5 out of 15. We have never seen a direct vessel passing to either part of the main group.

From the greater part of the transverse colon the vessels enter the paracolic glands; they run parallel to the gut along the arterial arcade in either direction, and are invariably intercepted after a longer or shorter course by these glands. We have never seen them enter even the intermediate groups of the middle or left colic chains. It is only as we approach the flexures that we find vessels passing by the paracolic glands.

In the left half or two-thirds of the transverse colon there is an additional outlet for the lymph. In well-injected specimens we find that vessels arise from the anterior surface of the colon, run into the gastrocolic omentum, and then turn to the left between the ascending layers of this fold to reach, finally, the glands at the hilum of the spleen. The vessels from the middle of the transverse colon are necessarily very long, and there may be small interrupting nodules on them. We have also noted in two cases vessels ascending from the back of the upper end of the descending colon (lower limb of the splenic flexure) to the splenic glands.

OPERATION FOR GROWTHS IN THE MIDDLE PORTION OF THE TRANSVERSE COLON.—We have noted above that the lymphatics of this segment are all intercepted by the paracolic glands. The removal of a length of bowel (3 to 4 inches), on either side of the growth with the corresponding portion of the mesocolon containing these glands, will suffice. It should be possible in all cases to preserve so much of the transverse colon as will permit an end-to-end anastomosis.

OPERATION FOR GROWTHS IN THE REGION OF THE SPLENIC FLEXURE (Fig. 5).—The left colic artery is defined as it leaves the inferior mesenteric vein, and is tied at this point

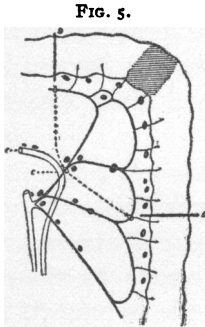


FIG. 5.
Excision of growth in the splenic flexure. *A*, growth; *B*, line of section of transverse colon; *C*, point of ligature of left colic artery; *D*, line of section of descending colon; *E*, inferior mesenteric vein.

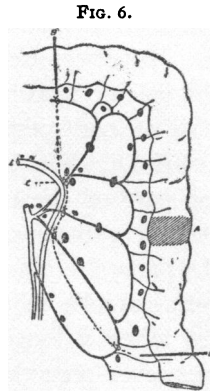


FIG. 6.
Excision of a growth in the descending colon. *A*, growth; *B*, line of section of transverse colon; *C*, point of ligature of left colic artery; *D*, line of section of sigmoid flexure; *E*, inferior mesenteric vein.

with the accompanying vein. The bowel is then freed by incising the peritoneum to the outer side of the descending colon and splenic flexure and separating the bowel with the growth, the peritoneum and the subperitoneal tissues containing the lymphatic glands and vessels from the posterior abdominal wall. The mesocolon is then divided from the point of ligature of the artery, upwards to a selected point on the transverse colon. The selection of this point will be determined by the extent of the transverse colon supplied by the middle colic artery; it will lie as a rule at the junction of

the middle and left thirds of the transverse colon. The peritoneum is also divided in a direction downwards and outwards to the descending colon. At the selected point on the transverse colon the bowel is divided; below, the descending colon is divided in its lower part and the operation is completed by an end-to-end anastomosis.

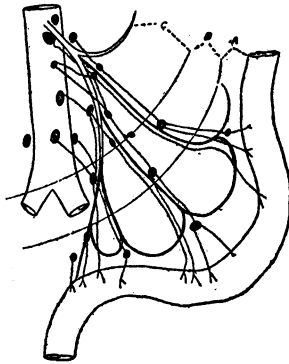
OPERATION FOR GROWTHS IN THE DESCENDING COLON (Fig. 6).—The “lymphatic area” corresponding to this part of the colon comprises the epicolic and paracolic glands and the intermediate glands on the branches of the left colic artery, including those on the uppermost sigmoid artery. Some vessels also run to the splenic glands, as in the case of the splenic flexure. It will then be necessary to tie the left colic artery at the point where it leaves the inferior mesenteric vein, and also the uppermost sigmoid artery close to its origin. A reference to the diagram will show that beyond this step the operation is much the same as that for the splenic flexure except that, below, the gut will be divided in the upper part of the sigmoid flexure.

The Inferior Mesenteric Chain.—This chain of glands drains the sigmoid flexure and rectum. The paracolic glands lie in the position described above. The intermediate glands lie on the sigmoid arteries—those on the highest sigmoid branch being found between the lower end of the kidney and the iliac crest, those on the other branches in the root of the mesosigmoid. The main group surrounds the inferior mesenteric stem below the origin of the left colic chain, both chains becoming continuous with the lumbar glands at this point. Direct vessels reach the intermediate glands in all cases. The lower end of the main group necessarily lies near the intestine at the pelvic brim and is comparable to the paracolic group in other parts, receiving therefore numerous direct vessels. The middle portion of the chain is in series with the intermediate glands on the sigmoid arteries and receives direct vessels, but the upper part of the chain never receives vessels directly from the gut, resembling in this respect the main group of the left colic chain. From

all parts of the group vessels pass to the lumbar glands (Fig. 7).

THE OPERATION FOR GROWTH IN THE LOWER PART OF THE SIGMOID FLEXURE AND THE FIRST PART OF THE RECTUM (Fig. 8).—~~This may conveniently be considered before we discuss the operation for a growth in the middle of the sigmoid flexure.~~ The glands requiring removal are those lying around the inferior mesenteric artery and its continuation, the superior hæmorrhoidal artery, from the point of origin of the left colic artery downwards,—this includes all the primary lymphatic glands. It is not necessary to remove the

FIG. 7.



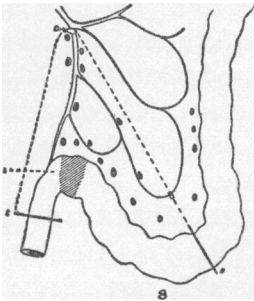
Showing how the lowest and middle glands of the inferior mesenteric chain are homologous with the paracolic and intermediate groups on the sigmoid arteries. A, paracolic group; B, intermediate group; C, main group.

glands around the stem of the inferior mesenteric artery above the point of origin of the left colic artery; these glands are not primary glands and are indeed less likely to become diseased from a growth in the situation we are now considering than are the lower glands of the lumbar group. Further, if these glands are secured by ligaturing the inferior mesenteric stem close to its origin from the aorta, the blood supply of the upper segment of bowel will then depend entirely on the anastomosis between the left colic and middle colic arteries, which may be insufficient.

The operation consists in exposing the inferior mesenteric artery and ligaturing it and the vein just below

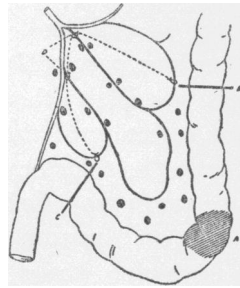
the point of origin of the left colic artery.) A long incision through the peritoneum is made on the outer side of the mesorectum, mesosigmoid, and descending colon, and the gut mobilized by stripping it inwards towards the middle line. In doing this the ureter and spermatic vessels are encountered and must be avoided. The mesosigmoid is then divided in an oblique line downwards from the point of ligature of the inferior mesenteric to about the middle of the sigmoid flexure, care been taken to preserve as far as possible the secondary arches on the sigmoid arteries. The peritoneum

FIG. 8.



Excision of a growth at the junction of the sigmoid flexure and the rectum. *A*, growth; *B*, line of section through the sigmoid flexure; *C*, line of section through the rectum; *D*, point of ligature of the inferior mesenteric artery.

FIG. 9.



Excision of a growth in the middle of the sigmoid flexure. *A*, growth; *B*, line of section above the growth; *C*, line of section below the growth; *D*, the sigmoid arteries tied at their origin. (Proc. Roy. Soc. of Me.)

to the inner side of the artery is then divided downwards to the inner side of the mesorectum. The mass of tissue to be removed is then stripped forwards from the sacral hollow and the middle sacral artery is secured. The peritoneal reflection from the bladder to the rectum is divided.

The operation may be terminated in one of three ways. (*a*) By cutting across the rectum below and the sigmoid flexure above, closing the rectum by sutures and effecting a permanent colostomy,—an undesirable method but one which will be necessitated in a certain, perhaps considerable, proportion of cases. (*b*) By dividing the rectum and sigmoid colon as above and effecting an anastomosis from within the abdomen. The vitality of the lower segment depends on the

middle and inferior hæmorrhoidal arteries and branches of the sacral arteries. We have not yet enough evidence that these are sufficient in all cases to permit the retention of a length of the rectum necessary for the performance of an anastomosis. (c) By making a perineal incision, pulling the whole mass of tissue through the outlet of the pelvis and anastomosing the middle of the sigmoid flexure to the anal stump (Maunsell, Tuttle, etc.).

Of these three methods the third appears to be the best. There will be many cases, however, where owing to the poor condition of the patient, to excessive stoutness, to distention of the bowel, etc., it will be impossible. In such cases a colostomy is indicated. In cases where an iliac colostomy has been done previously on account of obstruction, although it may be possible to close the opening and effect an anastomosis after resection of the growth, it will probably be wisdom to preserve the colostomy permanently.

OPERATION FOR GROWTHS IN THE MIDDLE AND UPPER PART OF THE SIGMOID FLEXURE(Fig. 9).—The lymphatic glands receiving direct vessels from this part of the colon include the epicolic and paracolic glands, the intermediate glands lying on the sigmoid arteries in the mesosigmoid, and the main group glands on the inferior mesenteric artery. The "ideal" operation in these cases is practically the same as that described above, with the difference that more of the mesosigmoid will be removed and the gut will be divided above at the junction of the descending colon and the sigmoid flexure. This "ideal" operation will be terminated in a certain proportion of cases by a permanent colostomy, and it must be remembered that the purely local excision of growths in this situation, with preservation of the alimentary circulation, has been attended with a considerable measure of permanent success. If the "ideal" operation necessitates a colostomy the comparative disadvantage is so enormous that it will rarely be performed. Being unwilling to consider even the possibility of a permanent colostomy after excision of a growth in the middle of the sigmoid flexure, we must

perform an operation which if short of the ideal does remove the majority of the possibly affected glands.

The operation consists in exposing the inferior mesenteric vessels, dividing the peritoneum over them and stripping off as many of the glands of the main group as is possible without damaging the vessels. This is done from the point of origin of the left colic artery down to the origin of the lowest sigmoid artery. The sigmoid arteries are tied at their origin, the lowest being preserved if its ligature be not necessitated by the position of the growth. The descending colon is then mobilized and the gut divided above at the junction of the descending colon and the flexure, and below in the lower part of the flexure. Almost the whole of the mesosigmoid will thus be removed, including the intermediate, paracolic, and epicolic glands and probably the greater number of the main group glands corresponding to this part of the sigmoid flexure. The operation is terminated by an end-to-end anastomosis between the end of the descending colon and the lowest part of the sigmoid flexure. If it is found necessary to tie the lowest sigmoid artery at its origin care must be taken to divide the gut well below the level of the brim of the pelvis, in order to avoid the "dead end" which may be left, as Manasse and Archibald have shown, owing to the non-union of the branches of the lowest sigmoid and superior hæmorrhoidal arteries.

In a recent paper, Dr. W. J. Mayo⁷ gives diagrams of suggested operations for cancer of the colon, designed to remove the associated lymph-glands. He does not give any reference to the writings or specimens on which his anatomical descriptions are based, and the accuracy of these is open to criticism in many respects. We may note that the tendency of the lymph drainage of the descending colon is not towards the transverse mesocolon, following the middle colic tributaries, as Dr. Mayo states; the lymphatic vessels run with the left colic artery. The lymph drainage of the splenic flexure and adjacent transverse colon is in the opposite direction to that of the hepatic flexure and the greater part of the

transverse colon. Their direction would only be the same if the middle colic artery supplied the whole of the transverse colon, including the hepatic and splenic flexures, which is not the case.

In Dr. Mayo's diagrams (Figs. 7 and 8 in his paper¹) showing the lines of the proposed resection of the sigmoid, it will be noted that a considerable loop of sigmoid colon is shown to be left, below the portion which is resected. As the inferior mesenteric artery has been tied the blood supply of this loop depends entirely on the middle and inferior hæmorrhoidal arteries and on twigs from the sacral arteries; it is questionable whether this will suffice for such a length of bowel as is depicted.

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- ⁴ de Bovis: *Rev. de Chir.*, 1900, xxi, pp. 673, and xxii, pp. 49, *et seq.*
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