Surgical Section.

SUB-SECTION OF PROCTOLOGY.

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Mr. F. SWINFORD EDWARDS, President of the Sub-section, in the Chair.

Some Points relating to the Surgical Anatomy of the Arterial Supply of the Large Intestine.

By HAMILTON DRUMMOND, F.R.C.S.Ed.

IN recent years much has been written concerning the arterial anastomoses of the large intestine, and so I have paid some attention to the subject, and have carried out certain injection experiments, and I venture to ask your attention to the results.

These injections have been carried out to illustrate in the first place the marginal artery of the colon and its anastomoses, and secondly, the anastomoses occurring between the pelvic colon and rectum. The vessels entering into the anastomosing branches of the various colic arteries forming the marginal artery of the colon have been given special attention to by Archibald,[1] who in a paper dealing with the operative treatment of cancer of the rectum states and proves by experiments on animals and post-mortem subjects that the circulation-forming anastomoses between the middle and left colic arteries, the left colic and sigmoid arteries, are so free by way of the communicating loops situated near the mesenteric border of the bowel, that one need only take care to spare these loops in ligating the vessels of the meso-sigmoid and the mesocolon. He proved to his own satisfaction that it was possible by freely dividing the mesocolon and its vessels that the iliac colon could be successfully brought down to the anus after complete removal of the pelvic colon and rectum.

[1] *Journ. Amer. Med. Assoc.*, Chicago, 1908, li, pp. 573-79.

He performed this operation upon a subject suffering from old tuberculous proctitis, in which he had failed, after repeated attempts, to close an artificial anus of the iliac colon. The patient died some time later, but post-mortem examination showed no signs of failure of the circulation in the bowel brought down. In his post-mortem investigations, he found by injecting a solution of red lead from the thoracic aorta, and ligature of the superior hæmorrhoidal artery and the sigmoid branch at their origin, that the circulation was maintained through the whole of the pelvic colon. Again he found that by ligature of the inferior mesenteric artery near its origin, and additional ligatures on the sigmoid arteries and left colic, also at the origin, the circulation was maintained through the pelvic colon as far as the rectum. In this latter experiment, the blood supply reached the bowel by means of the superior mesenteric artery through the so-called marginal artery, which runs along the edge of the bowel throughout the whole of the large intestine, being the anastomosing vessel between the superior and inferior mesenteric arteries.

His experiments, as a rule, showed that if the arterial supply of the decending colon, sigmoid and rectum, were cut off, still the circulation was maintained as far as the lower end of the sigmoid, provided that the vessels were ligated far back from the bowel so as to leave a broad flange of mesocolon containing the important anastomotic loops of the mesenteric border.

Sir Berkeley Moynihan,[1] in a paper on the surgery of the large intestine, emphasizes the importance of this vessel and states, "My own view is that however vessels are ligatured, and whatever sacrifice of mesentery may be thought necessary, it is almost impossible to deprive the cut ends of the colon, when resection is being done, of an adequate blood supply. Mortification due to anæmia is a myth. The marginal artery affords an ample supply of blood to all parts. The importance of this marginal artery, as far as the procedure of intestinal resection is concerned, cannot be over-estimated."

Rubesch[2] found that by injecting the main trunk of the superior mesenteric artery at its origin, the whole of the area supplied by the inferior mesenteric artery could be injected. In this experiment, the injection mass had ample opportunity of reaching the distal half of the large bowel, not only by the marginal artery, but by other large

[1] *Lancet*, 1913, ii, p. 4.

[2] Rubesch, *Beitr. z. Klin. Chir.*, Tüb., lxvii, 1910, p. 480.

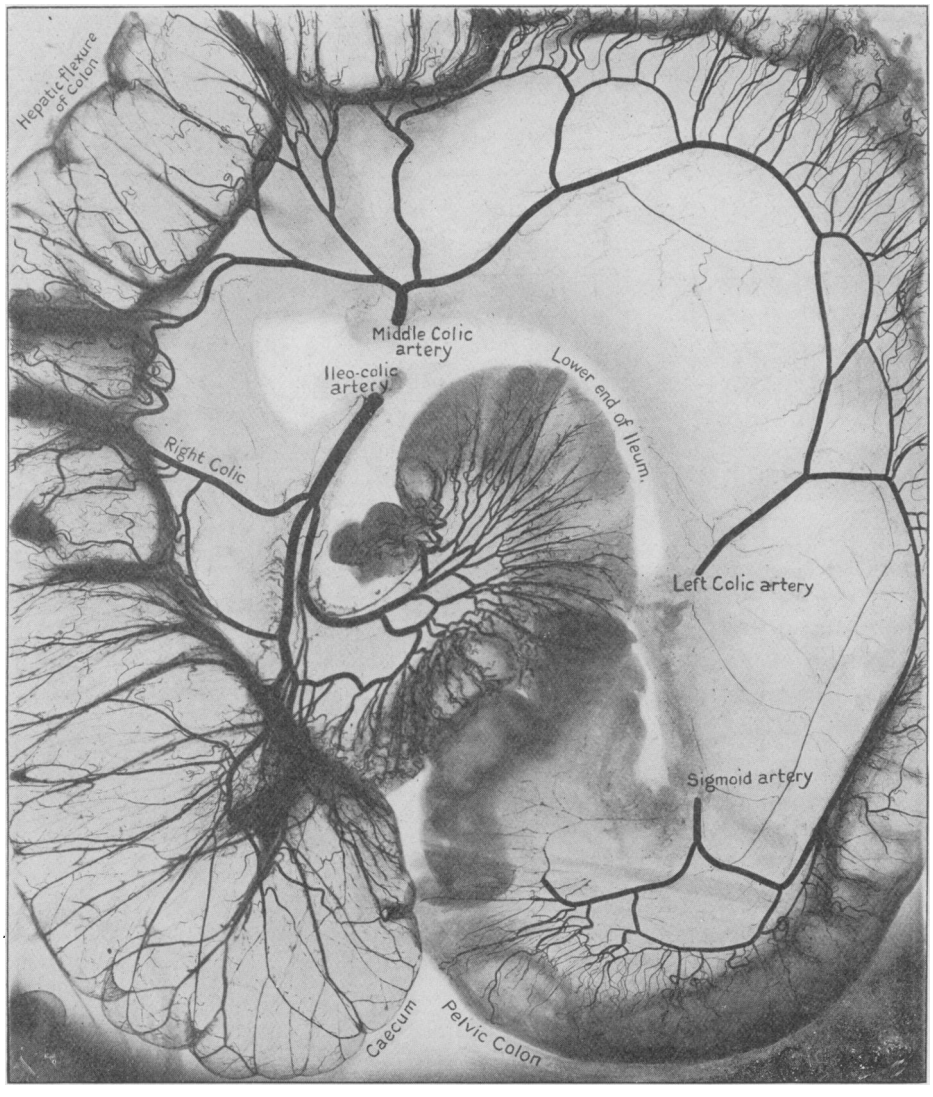

FIG. 1.

To illustrate the marginal artery of the whole of the colon. The specimen was injected through the ileocolic artery; ligatures have been placed upon the middle and left colic arteries, and on the sigmoid arteries. The injection travelled well into the pelvic colon area.

anastomosing branches between the various colic and sigmoid arteries lying some distance from the bowel.

In order to prove the value of this so-called marginal artery, which runs along the mesenteric edge of the large intestine, I carried out a series of post-mortem investigations with ligatures applied on the main trunk of the large intestine vessels in the course of this anastomosis. I found by injecting the ileocolic artery at its origin from the superior mesenteric vessel, and with ligatures placed on the right middle and left colic, and the sigmoid branches at points near their origin, that the vessels forming the marginal artery from the cæcum to the middle of the pelvic colon were well filled (*see* fig. 1). An additional ligature was applied to the branch of the superior mesenteric which supplies the lower end of ileum in order to prevent the injection reaching the aorta by way of the superior mesenteric artery.

Again, with the main trunks ligatured as before, and an additional ligature applied to the line of the marginal artery, where the junction of the middle and left colic arteries meet in the region of the splenic flexure (marked +, fig. 2), the injection travelled no farther than the descending colon, the vessels of the iliac and pelvic colons not being injected. As a rule, before the injection carried farther than the point ligatured on the marginal artery the vessels burst as the result of injecting at too high a pressure.

These observations on the dead body are of interest, but from a practical point of view, in life, of course, no such liberties could be taken. The amount of ligaturing of vessels would certainly result in gangrene.

Of experimental work on this subject I have not been able to find much helpful literature, with the exception of a reference to Morestin.[1] He found that by ligature of the inferior mesenteric artery in dogs during life the circulation was easily re-established. He performed this operation on five animals. Then, again, we must remember that the intestinal anastomosis in animals is exceedingly prolific.

An interesting case bearing upon this point of ligature of vessels and implanting the bowel to a distant part is recorded by Treves,[2] who resected the large intestine from the splenic flexure to the anus, ligaturing the left colic, the sigmoid branches, and the superior hæmorrhoidal artery. The splenic flexure was brought down to the anus, and the patient, a girl, aged 6, made a good recovery.

With regard to the arteries entering into the anastomosis on the

[1] *Bull. Soc. Anat.*, Par., 1893.

[2] Treves, *Lancet*, 1898, i, . 279.

pelvic colon and rectum, the inferior mesenteric artery is given off from the abdominal aorta about 1½ in. or 2 in. from its lower end. About 1 in. from its origin the trunk gives off the left colic artery, which divides into an ascending and a descending branch. The upper branch anastomoses with a branch from the middle colic, and the lower anasto-

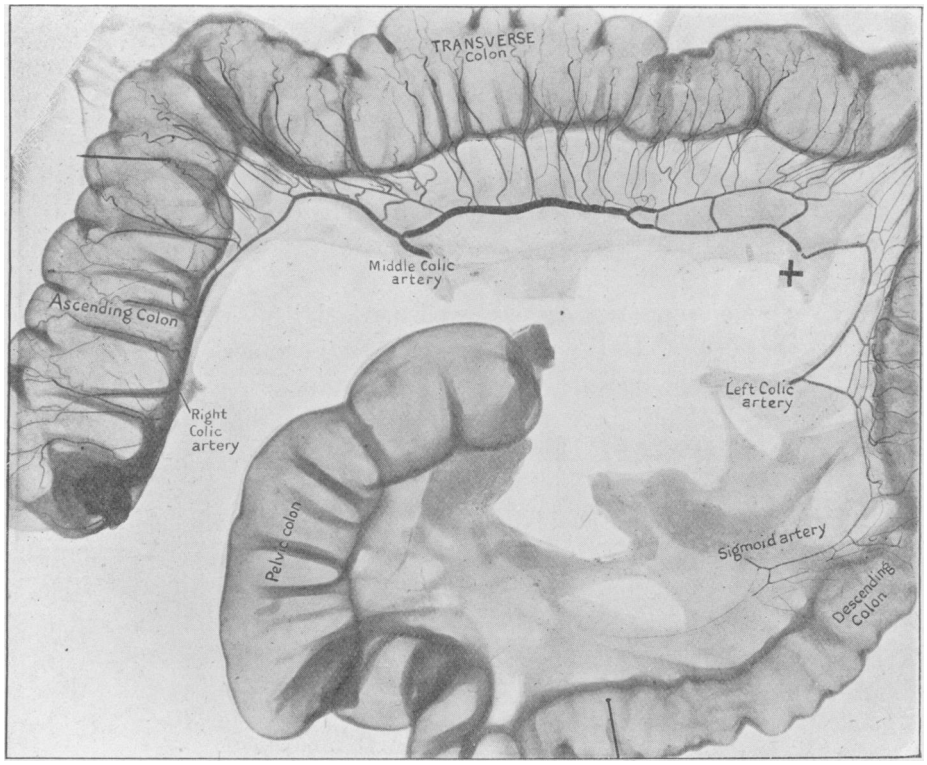

FIG. 2.

To illustrate the marginal artery. Specimen injected through the ileocolic artery. The ileocolic artery and cæcum have been removed, as injection burst in region of cæcum. Ligatures have been placed on right colic artery, middle and left colic arteries, and the sigmoid arteries, only one of which is seen. In addition to the above ligatures, the marginal artery has been ligated at the splenic flexure (*see* +), with the result that the injection travelled to the descending colon only before the vessels in the cæcum burst.

moses with the first of the sigmoid branches. A large loop is formed between the upper and lower branches of the left colic artery.

The sigmoid arteries from the inferior mesenteric supply the lowest part of the descending colon and the iliac and pelvic colons

by a series of loops which anastomose above with the lower branch of the left colic and below with the main trunk of the superior hæmorrhoidal artery.

The arcades which they form anastomose freely with each other, but the lowest sigmoid branch does not form an anastomosis with the superior hæmorrhoidal artery in this arcade fashion. The superior hæmorrhoidal artery forms no anastomosing arcade, but is, so to speak, a terminal artery. The arterial anastomosis at this point, the recto-sigmoidal junction, is of interest on account of the important bearing it has on operations devised to remove the lower colon and rectum (referred to in another paper).

Out of twenty injected specimens, the loop formed by the last sigmoid artery and the anastomosing branch above it was absent in two cases. In eight cases a loop was present, but very small vessels entered into its composition.

In the remaining ten cases a well-marked loop of some size was present (*see* fig. 3). In the majority of cases the superior hæmorrhoidal artery, before dividing into two terminal branches, gives off one or two branches, which come off at right angles to the main trunk and run round the bowel on each side, and having little anastomosis above or below.

The superior hæmorrhoidal artery divides, as a rule, at the upper end of the rectum, or, as these injected specimens show, about midway between the level of the promontory of the sacrum and the reflexion of the peritoneum. The vessel divides into two main branches, which spread out on the lateral aspects and front of the bowel. These two main trunks soon give off numerous small branches, which form a free anastomosis around the ampulla of the rectum, and which can easily be traced down to the upper end of the anal canal. On reaching the middle of the ampulla the branches perforate the muscular coat, and come to lie in relation to the inner coat of the bowel. Occasionally a high division of the superior hæmorrhoidal artery occurs, the vessel dividing into its two main trunks before the last sigmoid branch is given off.

I have often been struck by the variation in size of the middle hæmorrhoidal artery when assisting at the abdomino-perineal operation for removal of the rectum, for in some instances this vessel, when divided, is seen to spout freely at once, necessitating arrest of the hæmorrhage; whilst in others, so trifling is the bleeding, that no ligature is necessary, and these injections bear out this observation,

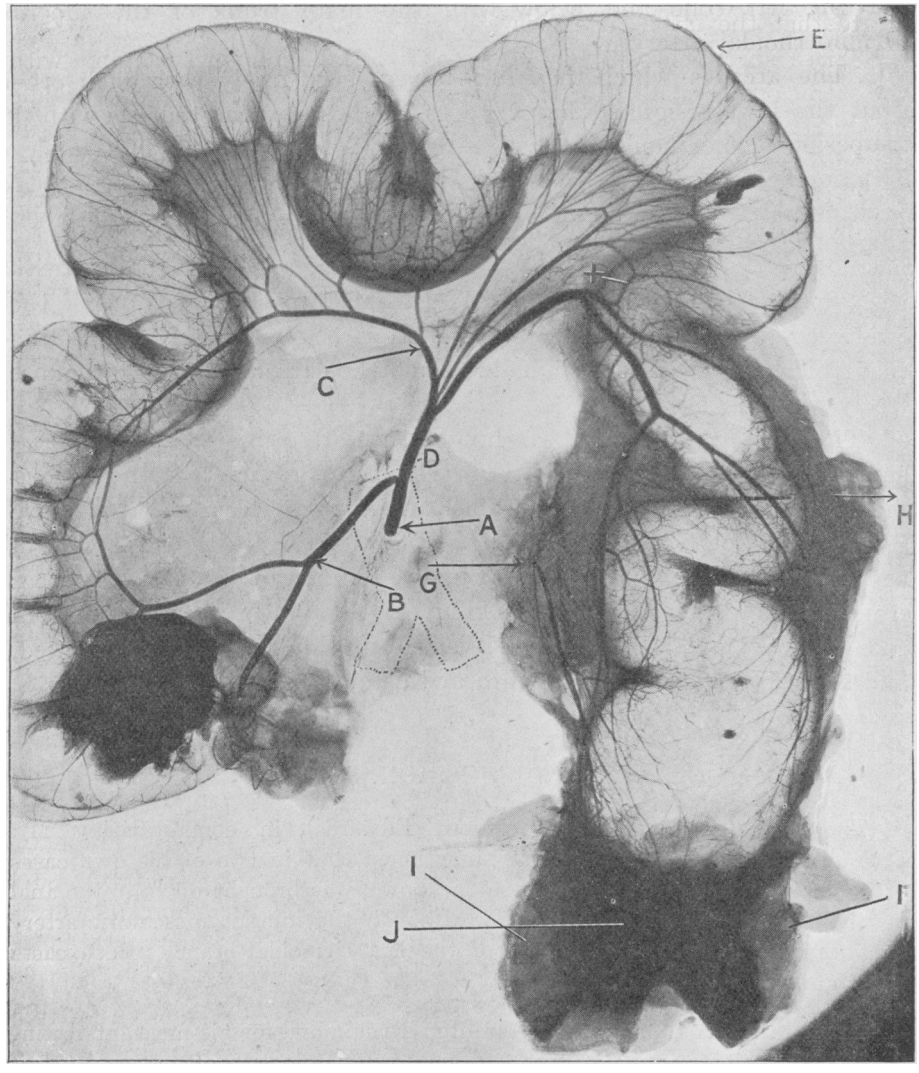

FIG.3.

Specimen showing arterial supply of rectum and pelvic colon injected through the inferior mesenteric artery, cut off from its origin with the abdominal aorta. **A**, inferior mesenteric artery; **B**, left colic artery; **C**, sigmoid branches; **D**, inferior mesenteric artery; **E**, pelvic colon; **F**, superior hæmorrhoidal artery; **G**, middle hæmorrhoidal artery; **H**, level of reflection of peritoneum; **I**, inferior hæmorrhoidal artery; **J**, anus. Shows recto-sigmoidal anastomosis. The middle hæmorrhoidal artery anastomoses freely with the branches of the superior hæmorrhoidal artery.

for they not only show the anastomosis between the superior and middle hæmorrhoidal arteries to be a variable one, but also demonstrate that the latter artery is a variable quantity (*see* fig. 3).

These specimens were all injected by the same method and with the same material. In only five out of twelve could the middle hæmorrhoidal artery be made clear. In all the specimens the tissue containing this latter artery was dissected off from the bowel, so injection could easily make it visible on the X-ray picture. From these specimens we may conclude that the middle hæmorrhoidal in most cases has not, as the text-books lead one to suppose, a free anastomosis with the superior hæmorrhoidal artery. In only two specimens out of the twelve could the inferior hæmorrhoidal artery be seen injected, suggesting that this artery, like the middle hæmorrhoidal, does not anastomose freely with the superior.

The subject to which I have invited your attention—viz., the arterial supply of the large intestine—is of great importance, and the experiments I have related and am illustrating make it clear that we have something yet to learn, especially with reference to the capability of the arterial anastomosis. How far one is justified in drawing inferences from experimental work of this kind carried out in the post-mortem room is, of course, doubtful, but I venture to think they are well based, and that surgical experience will bear this out.

DISCUSSION.

The PRESIDENT (Mr. F. Swinford Edwards), in congratulating Mr. Drummond on his admirable paper, mentioned that in two of his own cases of abdomino-perineal excision where the bowel was brought down to the anal margin some sloughing had occurred, although the inferior mesenteric artery had been divided about the origin of the last sigmoidal branch; both cases had, however, ultimately done well.

Mr. MUMMERY thanked Mr. Hamilton Drummond for his most interesting paper, and pointed out the great value to proctologists of papers of this description. He hoped that Mr. Drummond would publish with his paper illustrations which would clearly show the points brought out. Mr. Mummery mentioned a case in which, in doing an abdomino-perineal excision of the rectum, he had ligatured the inferior mesenteric artery close to the aorta and before it had given off any branches. The upper stump of the sigmoid was brought out through the abdominal wall to form a permanent colotomy, and the blood supply left proved quite adequate, and there was no trouble from sloughing of the bowel.

Mr. HAMILTON DRUMMOND, in answer to the President's remarks that he had had sloughing in the stump of bowel forming a sacral anus after ligating the inferior mesenteric artery above the last sigmoid loop, replied that either Mr. Edwards must have been unfortunate in having a small recto-sigmoidal loop in his cases, or possibly tension in the portion of the gut drawn down; he attached great importance to avoiding tension. He was interested to hear that Mr. Mummery was able to ligature the inferior mesenteric artery close to its origin in doing the abdomino-perineal operation with permanent colostomy, without bad result. He did not think it was safe to do this as a routine, but that a safer place to ligature the inferior mesenteric artery in this operation was directly below the origin of the left colic artery.

Case and Specimen of Multiple Polypi of the Colon becoming Carcinomatous.

By IVOR BACK, F.R.C.S.

F. P., AGED 24, actress, contracted dysentery while on tour in United States, in 1910. In 1912, gradual onset of symptoms—sense of weight and loaded feeling in rectum, tenesmus, and occasional slight bleeding from rectum. Marked lack of general health and loss of weight.

In 1913 she was examined in New York by two surgeons, who diagnosed multiple adenoma, by sigmoidoscopy. On her return to this country she went to a doctor in Surrey, who examined *per rectum* and suspected carcinoma, but was so doubtful on account of her age that he cut out a piece for microscopy. Report: Undoubted carcinoma. He then sent her to me. I did an abdomino-perineal excision in the first week of July, 1913. The operation was made difficult by the fact that the adenomata extended up into the transverse colon. They bulged from the colotomy when it was opened. But they gradually disappeared and were gone as far as the finger in the colotomy could reach in three weeks, leaving an apparently normal mucous membrane. The colotomy was performed through the left rectus muscle. Otherwise convalescence was uneventful, and she was able to get up in eight weeks. Since then she has steadily improved in health and appearance, and has put on weight rapidly.

I saw her a month ago, when she told me she had not felt so well for years, that she had almost complete control and warning with differentiation of flatus and fæces, and that she had one action *per diem*. She has gone back to her work on the stage.