

THE ARTERIAL SUPPLY OF THE RECTUM AND PELVIC COLON.

By HAMILTON DRUMMOND, NEWCASTLE-ON-TYNE.

OF recent years much has been written concerning the arterial anastomosis of the recto-sigmoidal junction. The injections, as illustrated in this paper, have been carried out to show, in the first place, the recto-sigmoidal anastomosis, and in the second, the anastomosis between the superior and middle hæmorrhoidal arteries.

Technique.—In the specimens the injection, consisting of barium sulphate and almond oil, was pumped with a strong syringe into the inferior mesenteric artery, cut off at its origin from the aorta. It was found that if the left colic artery was not tied, the injection in most instances would travel up and fill the vessels given off by the superior mesenteric. When a ligature had been applied to the superior mesenteric artery at its origin from the aorta, it was possible to inject, through the inferior mesenteric, the whole of the large and small intestine area up to the duodenum.

Rubesch¹ had already found that the injection of the whole could be brought about in the opposite direction by injecting through the superior mesenteric artery. This is an interesting anatomical fact, but clinically considered it seems unlikely that a collateral circulation could be provided quickly enough to prevent gangrene after ligation of the superior mesenteric artery.

The inferior mesenteric artery is given off from the abdominal aorta about $1\frac{1}{2}$ to 2 inches from its lower end. According to Jamieson and Dobson,² it arises from that vessel under cover of the duodenum. In carrying out these injections, I frequently found in children, and occasionally in adults, where there was no ptosis of the duodenum, that the inferior mesenteric artery originated from the abdominal aorta half an inch, or sometimes one inch, below the lower border of the duodenum.

About an inch from its origin the trunk gives off the left colic artery, which divides into an ascending and a descending branch.

The point at which the artery divides into its two main branches is a variable one. The upper branch anastomoses with a branch from the middle colic, and the lower one anastomoses with the first of the sigmoid branches, sending a vessel upwards in addition, as a rule close to the bowel, to join its upper branch.

A large loop is therefore 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.

These sigmoid arteries are given off in an erratic manner. Of 20 cases injected, the first of the sigmoid branches was given off from the left colic, or a

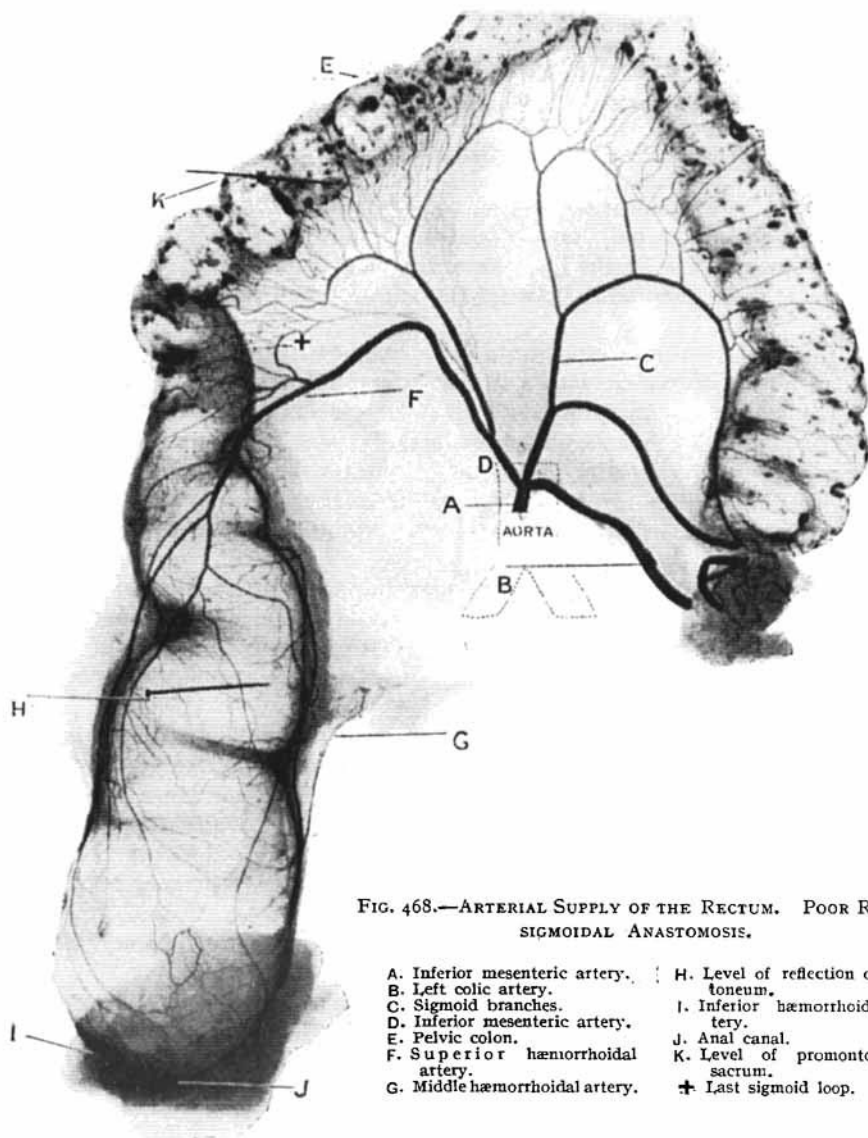
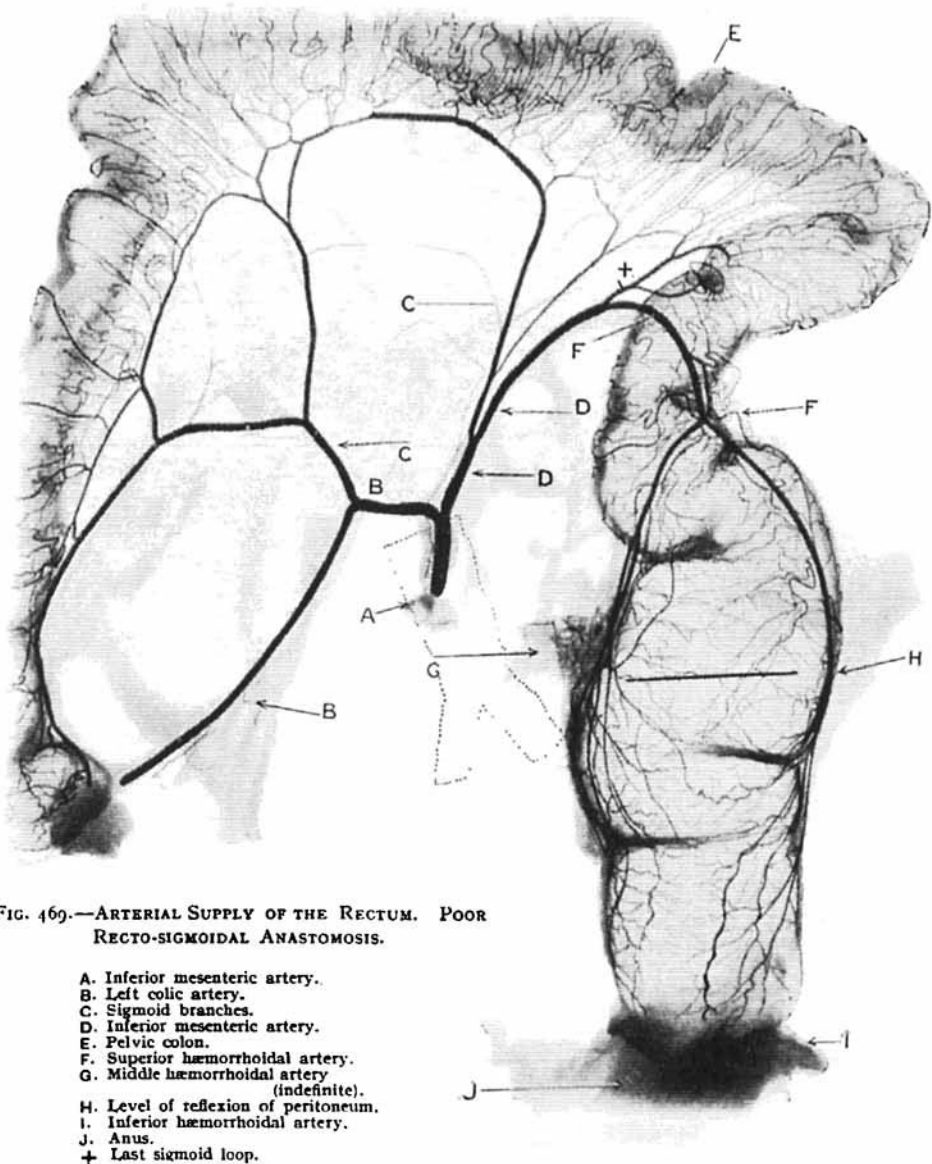


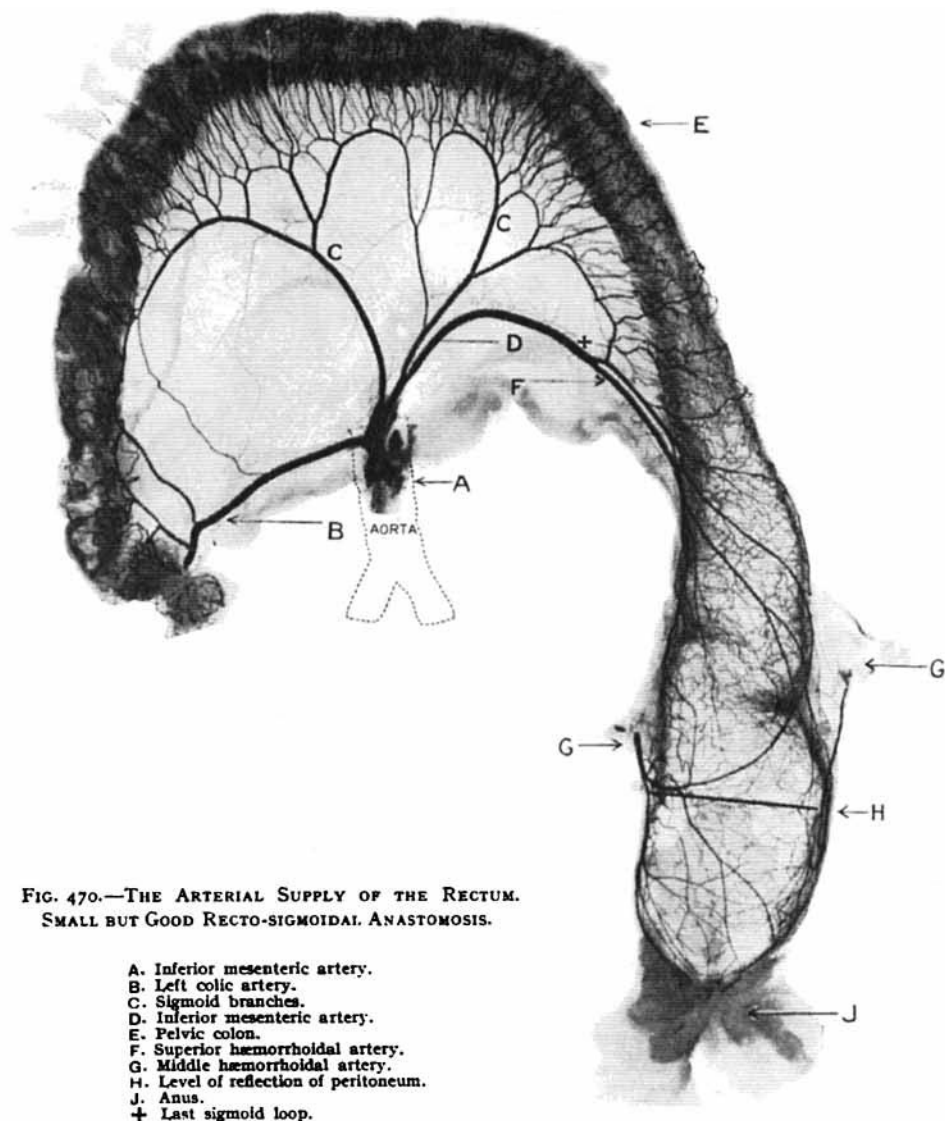
FIG. 468.—ARTERIAL SUPPLY OF THE RECTUM. POOR RECTO-SIGMOIDAL ANASTOMOSIS.

- | | |
|----------------------------------|---------------------------------------|
| A. Inferior mesenteric artery. | H. Level of reflection of peritoneum. |
| B. Left colic artery. | I. Inferior hæmorrhoidal artery. |
| C. Sigmoid branches. | J. Anal canal. |
| D. Inferior mesenteric artery. | K. Level of promontory of sacrum. |
| E. Pelvic colon. | ✕ Last sigmoid loop. |
| F. Superior hæmorrhoidal artery. | |
| G. Middle hæmorrhoidal artery. | |

The middle hæmorrhoidal artery is seen (G): in this case a small vessel which does not anastomose freely with the superior hæmorrhoidal artery. The branches of the latter artery freely supply the ampulla of the rectum. The spots in the pelvic colon are due to submucous ruptures of the injection under high pressure. The superior hæmorrhoidal artery divides midway between the level of the promontory of the sacrum (K), and the level of the reflection of the peritoneum (H).



The division of the two branches of the left colic artery is well shown. The middle hæmorrhoidal artery is represented by a bunch of minute twigs showing no definite anastomosis with the superior hæmorrhoidal artery, which supplies the lowest part of the rectum with long branches. The inferior hæmorrhoidal artery is seen on the right of the picture.



High bifurcation of the superior hæmorrhoidal artery (F). Very well-marked anastomosis between the superior and middle hæmorrhoidal arteries (F) and (G).

branch of it, 11 times ; in the remainder of the cases, 9 in number, it sprang from the main trunk of the inferior mesenteric artery.

The remaining two or three branches arise from the main trunk of the inferior mesenteric artery, the arcades which they form anastomosing freely with each other. 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.

Hartman³ found that, after operations by the sacral route upon carcinomata situated high up in the rectum, gangrene occasionally followed in the portion of the bowel which had been freed to permit of the establishment of a perineal or sacral anus.

De Dietrichs,⁴ one of many who has made post-mortem investigations on this point, showed that by ligation of the inferior mesenteric artery above the origin of the last sigmoid branch, the circulation of the rectum was not affected ; but ligation of the artery (inferior mesenteric) below the last sigmoid branch, arrested the circulation to the rectum, and gangrene in the living subject would be inevitable.

Hartman⁵ states that if the operator, after excision of the rectum, wishes to bring the bowel, with a satisfactory circulation maintained, down to the level of the skin of the perineum without traction, it is necessary to avoid cutting the superior hæmorrhoidal arteries where they are necessarily divided when working exclusively from the perineum. A ligature must be placed high up on the common trunk of these arteries, above the last anastomotic loop, which is to be found a little lower than the level of the promontory of the sacrum. To do this the abdomen must be opened. Hartman himself was the first to open the abdomen and tie the superior hæmorrhoidal artery to check hæmorrhage and to allow of an easier mobilization of the rectum. Sudeck,⁶ however, was the first to point out the importance of an abdominal incision in order to find the exact position of this anastomosis, which he called the C.P. (critical point).

A careful study of the blood-vessels of this part of the bowel shows that the last sigmoid branch of the inferior mesenteric not only varies considerably in size, but that it has an erratic communication with the sigmoid branch above. (Anastomosis marked +.) Out of my 20 cases, the loop between the last sigmoid artery and the anastomosing branch above it was completely absent in 2. In 8 cases a loop was present, but was so insignificant that one would certainly think it could not be good enough to carry on the circulation after ligation of the inferior mesenteric artery. In the other 10, a well-marked loop of some size was present. In the majority of cases, one or two branches which run around the bowel on each side, and have a little anastomosis above or below, are given off from the superior hæmorrhoidal artery below the last sigmoid branch.

The superior hæmorrhoidal artery divides—as a rule, at the upper end of the rectum or a little lower—into two main branches which spread out on the lateral aspects and front of the bowel. These two main trunks soon give off numerous

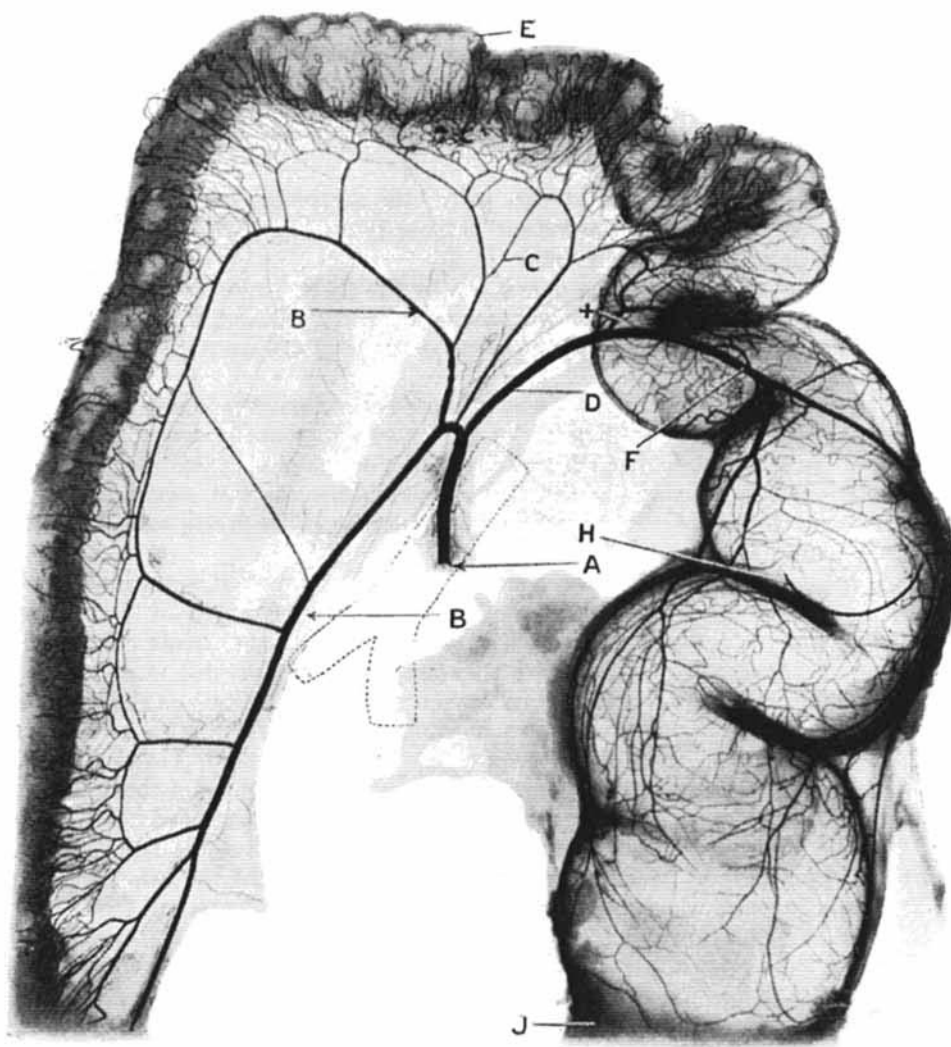


FIG. 471.—ARTERIAL SUPPLY OF THE RECTUM. GOOD RECTO-SIGMOIDAL ANASTOMOSIS.

- | | |
|--------------------------------|---------------------------------------|
| A. Inferior mesenteric artery. | F. Superior hæmorrhoidal artery. |
| B. Left colic artery. | H. Level of reflection of peritoneum. |
| C. Sigmoid branches. | J. Anus. |
| D. Inferior mesenteric artery. | + Last sigmoid loop. |
| E. Pelvic colon. | |

Sigmoid branches are seen arising from the left colic artery. The middle hæmorrhoidal artery is injected. The branches of the superior hæmorrhoidal artery are seen running down to the lowest part of the rectum.

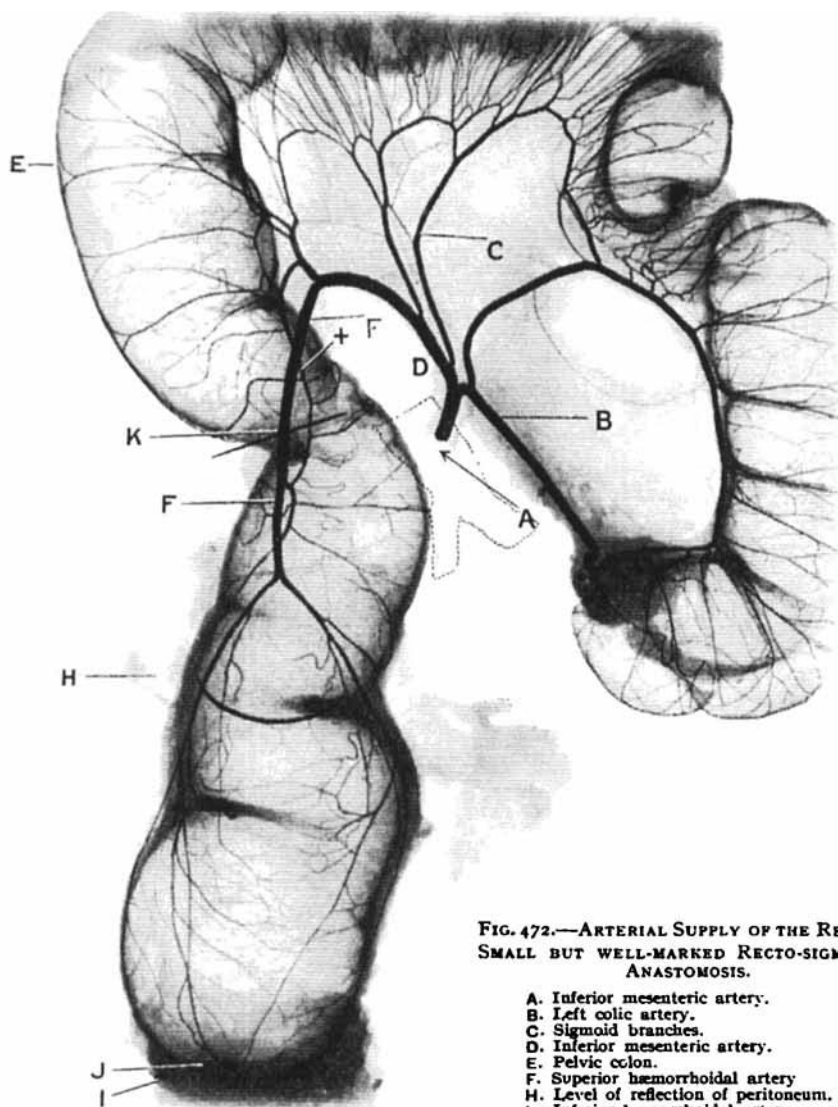


FIG. 472.—ARTERIAL SUPPLY OF THE RECTUM.
SMALL BUT WELL-MARKED RECTO-SIGMOIDAL
ANASTOMOSIS.

- 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.
- K. Level of promontory of sacrum.
- † Last sigmoid loop.

The left colic artery is seen dividing into two branches close to the origin of the artery. The middle hæmorrhoidal artery is absent; the ampulla and lower end of rectum are supplied by the branches of the superior hæmorrhoidal artery. Division of the superior hæmorrhoidal artery taking place about midway between the level of the promontory of the sacrum and reflexion of the peritoneum.

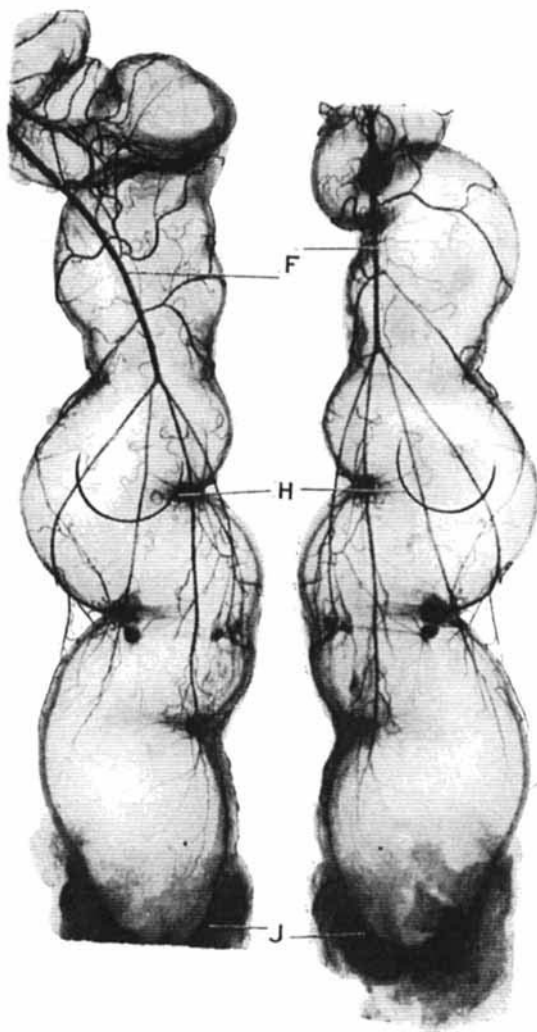


FIG. 473.--SPECIMEN OF THE LOWEST PORTION OF THE PELVIC COLON, RECTUM AND ANUS.

F. Superior hæmorrhoidal artery.
H. Level of reflection of peritoneum.
J. Anus.

The illustration well shows the way in which the branches of the superior hæmorrhoidal artery supplying the upper part of the rectum come off the main trunk at right angles, and anastomose very slightly with one another. The middle hæmorrhoidal artery is not shown. Illustrates well the breaking up of the main trunk of the superior hæmorrhoidal artery into its branches (in this case double).

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.

The anastomosis between the superior and middle hæmorrhoidal arteries is shown to be a variable one, for these specimens were all injected by the same method and with the same material. In only three out of twelve could the middle hæmorrhoidal artery be clearly shown. In all the specimens the tissue containing this artery was dissected off from the bowel, so that injection could easily make it visible on the *x*-ray picture if it was of sufficient size. From these specimens we may conclude that in most cases the middle hæmorrhoidal has not, as the text-books lead one to suppose, a free anastomosis with the superior hæmorrhoidal artery.

In only two of the specimens could the inferior hæmorrhoidal artery be seen—suggesting that this artery, like the middle hæmorrhoidal, does not anastomose freely with the superior.

CONCLUSIONS.

1. The anastomotic loop formed by the last sigmoid artery (marked + in the photographs) varies considerably in size and position, and in some cases may be absent.

2. Gangrene in the stump of the bowel brought down after high excision of the rectum by the sacral route may be due to (*a*) anatomical causes, or (*b*) tension sufficient to arrest the already handicapped circulation. It seems probable that tension is the more important of the two.

3. To insure that the inferior mesenteric artery is tied in a suitable situation, i.e., above the last sigmoid branch, it is necessary to open the abdomen. If the recto-sigmoidal loop is small, any attempt to draw down the bowel to the perineum is likely to result in gangrene, and permanent colostomy should be done.

4. In the abdomino-perineal operation for excision of the rectum, it is safe to ligature the inferior mesenteric artery immediately below the point where the left colic artery is given off when a permanent colostomy is made.

5. If the bowel above is to be brought down to the anus after excision of the rectum by the abdomino-perineal method, the most convenient place to ligature the inferior mesenteric artery is immediately below the first sigmoid branch, which is to be recognized by the large anastomotic loop it usually forms with the branch of the left colic artery.

REFERENCES.

¹ RUBESCH, *Beit. Klin. Chir.*, 1910, lxviii, 480.

² *Proc. Roy. Soc. Med.*, 1909, March.

³ *Ann. Surg.*, 1909, Dec.

⁴ Quoted by HARTMAN, *Ann. Surg.*, 1909, Dec.

⁵ *Loc. cit.*

⁶ *Münch. med. Woch.*, 1907, 1314.