

SAFETY FACTORS IN MESENTERIC LIGATIONS*

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THE surgeon is often confronted at the operating table with the problem of the viability of the intestine after damage to its circulation in such clinical cases as laceration of the mesentery, mesenteric thrombosis, and strangulated hernia. In lacerations of the mesentery, which are usually accompanied by severe hæmorrhage, one wishes to do the least possible surgical procedure—that is, ligation of the bleeding points and closing of the wound of the mesentery. Radical procedures such as resection of the bowel increase the danger to the patient's life. Recovery from wounds of the mesentery after mere ligation of the bleeding vessels has been reported by Bost.¹ In three cases occurring on the service of Dr. John H. Jopson, although death eventually resulted from complications, autopsy revealed a normal intestine at the site of the injury.

Ross² and Klein³ have reported cases of mesenteric thrombosis which have recovered without surgical interference other than simple laparotomy. In incarcerated hernia where the intestine is somewhat œdematous and doubt may exist as to the competence of the circulation, the bowel is replaced with the hope that the circulation will be reëstablished or a collateral circulation will form and so maintain the viability of the gut. Experience has taught us that this conservative measure is justified.

Anatomical studies of Dwight,⁴ Mall,⁵ and Eisberg⁶ of the arterial supply to the intestine and, especially, Eisberg's study of the arterial supply to the intestinal coats, have given us a clear understanding of the vascular supply of this structure. Eisberg observed that "the blood supply consists of vasa recta arising from the last series of mesenteric arcades and passing directly to the intestine. These vessels generally alternate, one passing in front of, the other behind, the intestine. The vasa recta in passing between the serosa and the muscularis, give off numerous lateral offshoots which unite with similar branches from adjacent arteries. They pierce the muscle coat in the mesenteric quarters. They branch out in tree-like fashion as they approach the anterior mesenteric border and anastomose freely with the similar branches of the arteries of the opposite side. Numerous branches are given off from vasa recta at right angles to the vertical axis of the gut. These branches in turn divide and inosculate with similar branches above and below, as well as laterally, in the submucosa and mucosa. From the plexuses in the latter situation, arteries also arise from the terminal arcades and directly from the vasa

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recta before the latter reach the muscularis." He believes that there is a well-defined mesenteric border arterial anastomosis in addition to the vasa recta.

Monks⁷ has drawn attention in his exhaustive study of the mesenteric vessels, to the variations of arcade of the mesenteric vessels to the different portions of gut. He has suggested that a segment may be localized from a study of the vascularization. In the duodenum there is an occasional arcade; these arcades increase in number in the jejunum until a plexus formation is found in the terminal ileum.

In the intestine of the dog the blood supply is considerably different. Com-

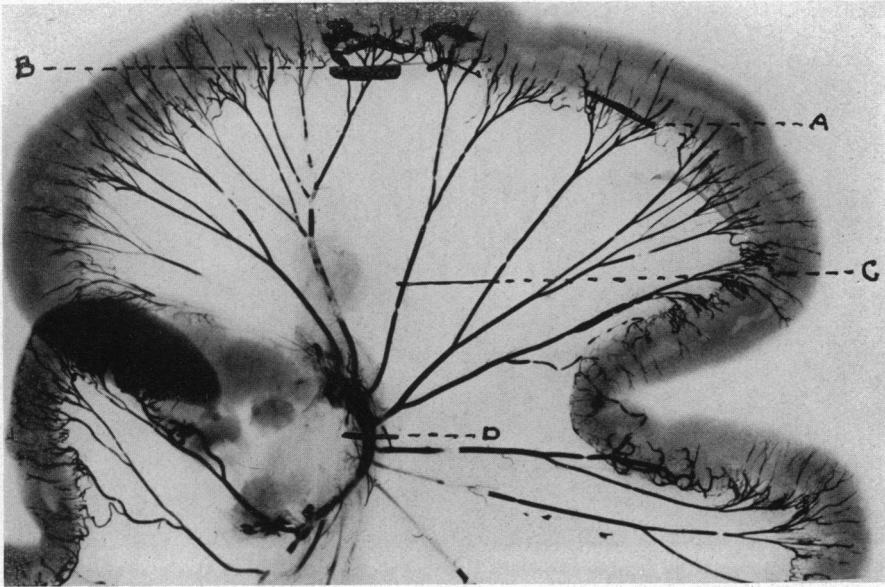


FIG. 1.—Section of intestine of dog with injection of the arteries with oxychloride of bismuth. A, B, C, D show the points of severance of the blood vessels. This specimen does not show the arcades, although that was one of the points at which severance was made.

ing off from the mesenteric artery we, as a rule, have numerous branches which at times form one, but rarely more than two, arcades, from which the vasa recta arise. In the majority of instances there is a distinct marginal artery running along the mesenteric attachment to the intestine. This vessel varies in size and at times is so small as to be hardly recognizable.

From an anatomical study one would expect a greater margin of safety in the human because of the extensive vascular plexus formation in the mesentery. (Figs. 1 and 2.) Our experiments were performed upon dogs under amytal anæsthesia (fifty milligrams per kilo), using aseptic precautions. In each instance the vessels, veins and arteries were severed between ligatures, and the opening thus formed was closed. In one case the site of the opening was covered with a portion of omentum. Several conditions were noted constantly. After severing of the vessels, that portion of the intestine supplied by the severed vessels contracted and became purple. Mall⁵ made the same

observation with the exception that the intestine became ischæmic. It was also noted by me that the pulsation of all vessels distal to the ligation ceased. Severance of the vessels was performed at five points: (1) Along the mesenteric attachment; (2) through the vasa recta; (3) through the arcade; (4) through the main branches; and (5) through the mesenteric artery. Several of the above series were carried on in the same dog.

Series A. Severing of the mesentery along its attachment to the small intestine. Dog No. 1.—Severance of the mesentery for two inches along its attachment; died six days later with gangrene of the intestine.

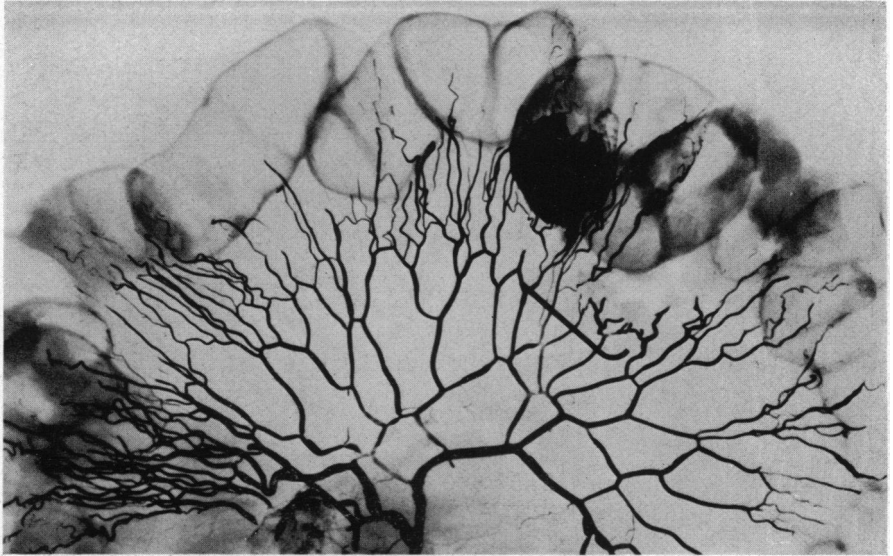


FIG. 2.—Injection of the superior mesenteric artery of the human with oxochloride of bismuth of a portion of small intestine twelve inches from the duodenal jejunal junction. One notes the first, second, and third arcades of this vessel before the vasa recta are given off point of ligation.

Dog No. 2.—Severance of the mesentery for a distance of three inches along its attachment; death twenty-five days later; normal intestine found at autopsy.

Series B. Dog No. 3.—Severance distal to the first arcade; portion of omentum placed at site of severance. Autopsy five months and twelve days after operation revealed a normal intestine and numerous adhesions. These vessels were injected with iodized oil and X-rayed. This (Fig. 3) demonstrated that the original vessels distal to the point of ligation contained the iodized oil and that the circulation had been reestablished through the same vessels. On sectioning the omental graft, we could see the vessels containing iodized oil.

Dog No. 4.—Resection in front of the first arcade for a distance of six inches. Autopsy five months later revealed a normal intestine with numerous adhesions.

Series C. Dog No. 5.—Severance of first arcade supplying five inches of intestine. Autopsy four months and four days after operation showed normal intestine with adhesions.

Dog No. 6.—Severance of first arcade supplying five inches of the intestine. Autopsy seven months and ten days later revealed a normal intestine.

Series D. Dog. No. 7.—Severance above the root obstructing five inches of blood supply. Autopsy four months later showed normal intestine. Figure 4 shows an X-ray of this intestine after the vessels had been injected with a solution of oxochloride of

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bismuth. Here we find that the marginal artery of the segment adjacent to the ligated portion is well developed, and that there are a few small arteries appearing at the site of ligation.

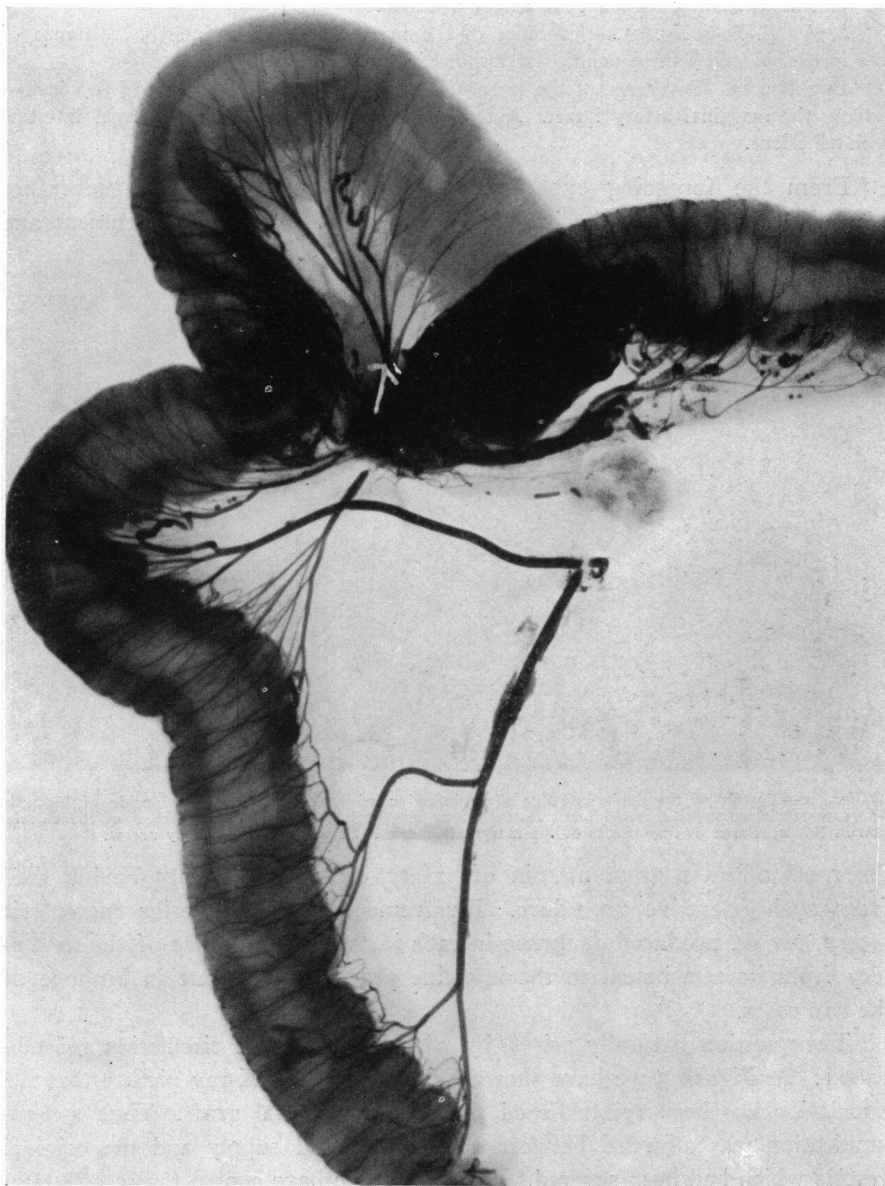


FIG. 3.—Section of intestine found at autopsy of dog five months and twelve days after operation. Vessels were injected with iodized oil. Picture shows the reestablishment of the circulation through the same vessels.

Series E. Dog No. 8.—Severance at the root, four to five inches of intestine involved; died three days later. Autopsy showed gangrene of intestine.

Dog No. 9.—Severance at the root, supplying six inches of intestine; died two days later, showing gangrene of the intestine.

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Dog No. 10.—Severance at the root, supplying five inches of intestine; died five days later; gangrene of the intestine.

In the large intestine, there is a distinct marginal artery. It was our desire to resect the mesentery, leaving the marginal artery attached.

Series F. Dog No. 11.—Severance of the meso of the large intestine, distance of two inches. Autopsy three months later showed a normal large intestine.

Dog No. 12.—Severance of the meso of large intestine for a distance of five inches, leaving the marginal artery intact. Autopsy five months later showed normal intestine with adhesions.

From the foregoing experiments one can readily see that severance of the blood supply of the intestine between the mesentric attachment and

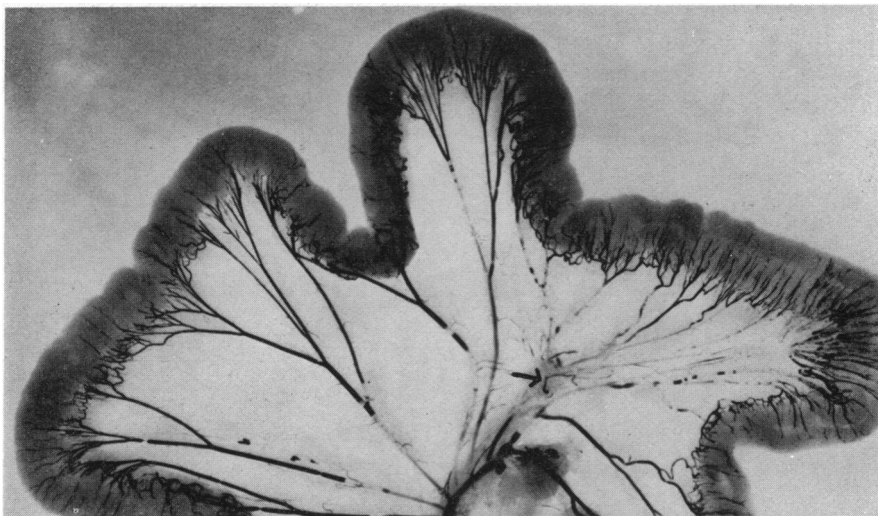


FIG. 4.—Vessels of the dog's intestine after injection with a solution of oxychloride of bismuth. These vessels were severed at the root. Autopsy four months later. The reestablishment of the circulation in this specimen was by means of the marginal arteries. Severance indicated by arrow.

the roots offers a great margin of safety, none of the dogs having died from such operative procedure. Involvement of the superior mesenteric artery, *per se*, produced gangrene in each instance. Severance of the mesentery from its attachment to the intestine produced gangrene in but one of the two cases.

The question naturally arises, by what means is the circulation reestablished? In Figure 3 we have shown by means of the X-ray picture that the circulation has been reestablished through an omental graft. Thus a communication was afforded between the intact blood supply and the original vessels which had been severed. In Figure 4 we have shown that a collateral circulation was established by the blood vessels adjacent to the severed vessels and that the collateral circulation was established through the marginal artery.

Numerous adhesions were found in all the cases. Some of these adhesions were found at the site of the severance while others were found along the intestinal wall. They were as a rule very filmy in character and grossly did

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not show blood vessels of any considerable size. Eisberg⁸ believes that the development of adhesions between loops of gut and the omentum are beneficial to the recovery of the affected gut. He also states that there is no evidence of the formation of new blood vessels through these adhesions. I am fully in accord with the first statement. As to the latter one, I feel sure that microscopic sections of the omentum at the site of adhesion would show vas-

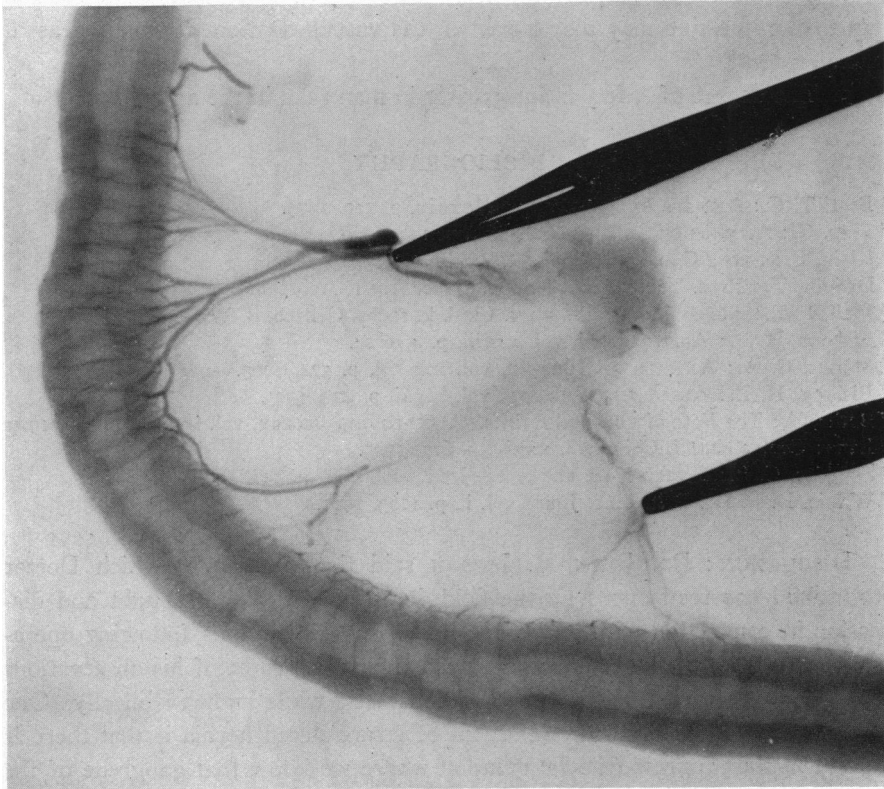


FIG. 5.—Vessels of the dog's intestine injected with iodized oil. This shows marginal artery conveying material to the part supplied by the separate vessels. Severance indicated by arrow.

cularization since Bothe⁹ has demonstrated vascularization of even free grafts in a very short time after transplantation. Lanz,¹⁰ Scudder,¹¹ and Wilkie¹² wrapped omentum around portions of the intestine from which the blood supply had been ligated. Wilkie found intestine intact over three and one-half centimetres long which had had its blood supply ligated. However, it was of no avail over larger areas.

CONCLUSIONS

1. Interference with the circulation of the small intestine between the mesenteric attachment and the superior mesenteric artery is not usually accompanied by gangrene of the intestine. Interference with the superior mesenteric artery results in gangrene of the bowel. Detachment of the mesentery from

the intestine may not result in gangrene of the bowel. Severance of the mesentery of the large bowel, permitting the marginal artery to be left intact, does not interfere with the viability of the large intestine.

2. The reestablishment of the circulation in the dog by means of the marginal artery of the segment and by means of formation of new vessels communicating with the vessels severed has been demonstrated. The adhesions in all probability do not play an important part in this. Adhesions of the omentum to the intestine may play a part in the vascularization of small areas of devitalized gut.

3. The degree of safety is far greater in man than in the animal.

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DISCUSSION: DR. JOHN H. JOPSON said that this paper which Doctor Rothschild has read opens up the field for a good deal of thought and discussion in connection with accidental and purposeful lesions following operations on the intestine or injuries to its blood supply. Some of his observations offer an explanation for what we have for a long while known clinically. One of the earliest lessons in the treatment of strangulated hernia is that there is a point in the progress of strangulation where we know that gangrene of the bowel will occur if not resected, and there is another group in which we are reasonably sure the viability has been preserved; and then, a large middle group in which experience many years ago taught us that return of the bowel is usually followed by recovery. The speaker recalled hearing Doctors Wharton and Deaver tell about their own experiences when young operators and the lessons they learned from the teaching of D. Hayes Agnew, who, when watching operations of this type and asked for advice, advised them the bowel be put back; the patients got well. The experience of most surgeons has been that many of the cases which looked doubtful, but in which the bowel was returned, did preserve their viability.

Doctor Rothschild's experiments explain why these cases did not go on to gangrene and how the circulation was reestablished, by one or the other means which he has demonstrated experimentally. He mentioned the cases of

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mesenteric thrombosis reported by Ross and others in which nothing was done but a simple laparotomy.

Doctor Jopson had one such case in which he found extensive mesenteric thrombosis, in which the bowel was returned and nothing further done, and the patient recovered. Doctor Deaver has also had such a case. This problem has been brought home to all of us by operations on the large intestine and especially operations for carcinoma of the rectum in two stages. Doctor Rothschild and the speaker have had unfortunate experiences with ligations of the inferior mesentery artery above the point where it should have been. In fat subjects it is sometimes hard to define just where the line of safety is and they have had some patients go to gangrene. The suggestion of the interposition of a mesenteric graft, or use of it as a covering of the bowel, seems a distinct contribution. The percentage of cases in which it may be used is small, and although we must not apply his conclusions too radically (remembering that the vascularity in dogs is different from that in humans), it is to be hoped at the same time that this contribution will in the future offer a means of overcoming or getting around this question of gangrene in small percentage of doubtful cases.