SURGERY OF THE SMALL INTESTINE IN THE ADULT

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Foreword

The need for surgical operations on the small bowel has increased considerably in recent years. Chronic vascular insufficiency, acute mesenteric vascular occlusion, the blind loop syndrome, fistulas, and neoplasms, formerly regarded as rare indications, have become comparatively common. Improved management of acute intestinal obstruction, newer concepts of the place of surgery in regional ileitis and the superior mesenteric artery syndrome, as well as the use of small bowel procedures in the treatment of obesity, on the one hand, and malnutrition on the other, make it essential for the general surgeon to have a thorough understanding of the principles of small bowel surgery.

In this volume Doctors Colcock and Braasch have made available for the practicing surgeon an up-to-date presentation of all the important aspects of modern small bowel surgery.

J. Englebert Dunphy

Preface

Interest in the small intestine—and in its surgical diseases—has long been eclipsed by its near neighbors, the stomach and colon. We must recognize, however, that the small bowel is the most common site of gastrointestinal obstruction. Furthermore, small intestinal insufficiency, small bowel carcinoid tumors, mesenteric vascular insufficiency, nonpeptic ulcers, diverticular disease, and inflammatory disease of the small intestine have assumed an increasing importance in the surgical literature of recent times. We have attempted in this work to survey and coordinate current thinking and background material on all surgical disease of the adult small intestine and to integrate this with our considerable experience in these areas. To our knowledge, there is no other single source of this information available.

Our thanks for help in preparing this monograph go to Doctors Warren Nickerson, Claude Fortin, John Vansant, Alan Hume, Howard Denbo, and Clifford Chang, former residents in surgery at the Lahey Clinic Foundation. Our special appreciation is extended to Mr. P. D. Malone and Mr. Frank Steckel for art work, to Mr. George Buchanan for photographic illustrations, and to Mrs. Nancy Braasch, Mrs. Ruth Keddy, and Miss Charlotte Thompson for editorial assistance.

THE AUTHORS

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Chapter One

ANATOMY

LENGTH

It is surprising that such a simple measurement as the length of the small intestine should not be generally known since its practical application to resective procedures and the short bowel syndrome is so important. Most estimations of the length of the small intestine are made in the postmortem room or anatomy laboratory after removal of the mesentery, which allows considerable elongation of the bowel. Such measurements are usually about 22 feet; Treves[7] mentioned extremes of $15\frac{1}{2}$ and $31\frac{1}{2}$ feet.

Exact measurements of the length of the combined jejunum and ileum are difficult at laparotomy because of the obvious elasticity of the tissues involved. The mean length in situ of these two portions of the small intestine is most often estimated at 9 or 10 feet.[1] The duodenum is approximately 10 inches in length, either in situ or after removal from the body.

DUODENUM

The duodenum is divisible into four parts (Fig. 1-1). The first or superior portion is almost 2 inches in length, begins at the pylorus, and ends at the neck of the gallbladder, where it makes an abrupt descent. In profile it is cone-shaped, and it is covered by peritoneum for most of its extent except for its posterior portion. Its anterior relationship is often with the gallbladder or quadrate lobe of the liver; posteriorly it is contiguous with the gastroduodenal artery, the common bile duct, and the portal vein; and below and behind it is adjacent to the head and neck of the pancreas.

The second portion of the duodenum is about $3\frac{1}{2}$ inches in length and proceeds caudally from the first lumbar vertebra almost to the fourth.

It is covered by peritoneum anteriorly and overlies the spermatic or ovarian vein and the vena cava posteriorly and, variably, the hilus of the right kidney. Its inferior portion is covered by the peritoneum and vessels of the transverse mesocolon. Medially its convexity enfolds the head of the pancreas and is pierced by the termination of the common bile duct and the main and accessory pancreatic ducts.

The horizontal or third portion of the duodenum is approximately $2\frac{1}{2}$ inches in length and passes from right to left with some cephalad inclination over the upper border of the fourth lumbar vertebra. In so doing it passes over the vena cava and aorta, after which it terminates in the fourth portion. As it crosses the aorta, it in turn is crossed by the superior mesenteric vessels as they arise from their parent vessels and descend to the intestine. Superiorly, this portion of the duodenum is in relationship to the pancreas.

The ascending (fourth) portion of the duodenum measures about 1 inch in length and ascends as far as the upper border of the second lumbar vertebra, where it swings anteriorly to become the jejunum. This duodenojejunal flexure is suspended in the abdomen by a fibrous band, the ligament of Treitz, which in turn is attached to the connective tissue around the celiac artery and left crus of the diaphragm. The fourth portion of the duodenum is related posteriorly to the left psoas major muscle and left renal vessels.

It is then seen that the duodenum forms a C shape which clutches the head of the pancreas and is a fixed retroperitoneal organ covered in part by the mesocolon, stomach, colon, and gastrocolic omentum.

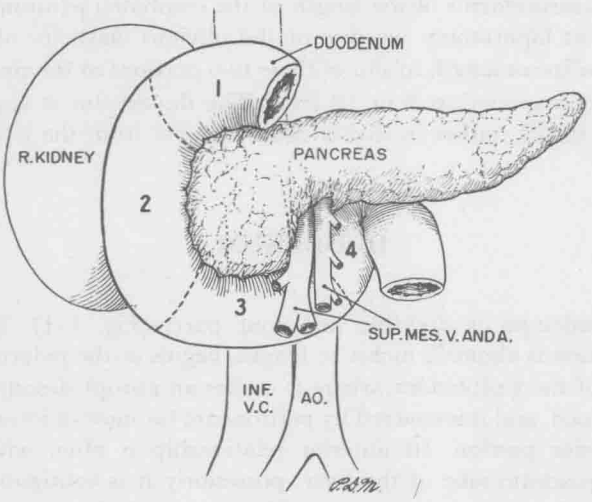

Figure 1–1. Divisions and relationships of the duodenum.

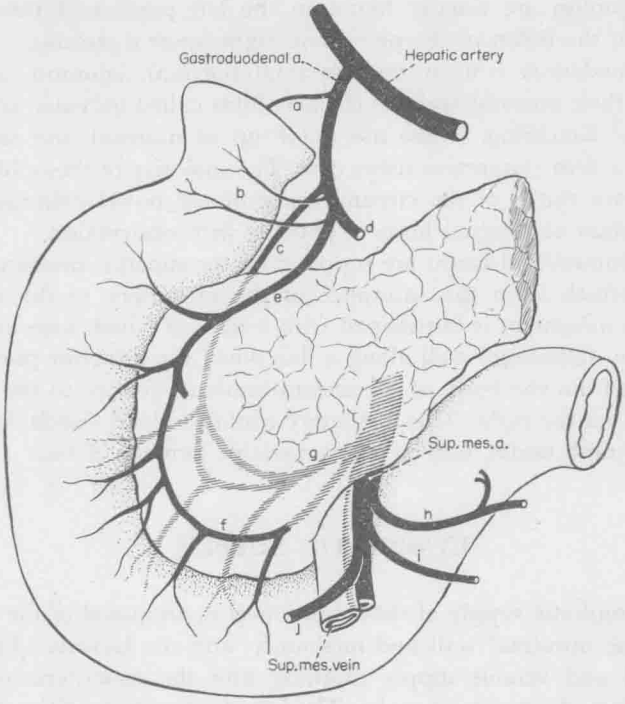

Figure 1–2. Arterial blood supply to duodenum. *a,* Posterior duodenal artery; *b,* anterior duodenal arteries; *c,* posterior superior pancreaticoduodenal artery; *d,* right gastroepiploic artery; *e,* anterior superior pancreaticoduodenal artery; *f,* anterior inferior pancreaticoduodenal artery; *g,* posterior inferior pancreaticoduodenal artery; *h,* duodenojejunal artery; *i,* jejunal artery; *j,* middle colic artery. (Adapted from Hollinshead, W. H.: Anatomy for Surgeons. New York, Paul B. Hoeber, Inc., 1956, p. 421.)

The arterial blood supply to the duodenum is derived from the hepatic and superior mesenteric arteries through the gastroduodenal, anterior, and posterior duodenal arteries and through the superior pancreaticoduodenal and inferior pancreaticoduodenal arteries, which anastomose to form an enmeshing network (Fig. 1–2). The venous supply is variable and drains into the splenic, superior mesenteric, and portal veins.

JEJUNUM AND ILEUM

The jejunum and ileum constitute the remainder of the small intestine and terminate in the right lower quadrant at a juncture with the cecum at the ileocecal valve. Proportionately the jejunum accounts for about two fifths of this combined length with the ileum making up three fifths. The

loops of jejunum are usually found in the left portion of the abdomen and those of the ileum in the pelvis and right lower quadrant.

The duodenum (except the proximal portion), jejunum, and ileum present on their mucosal surfaces circular folds called valvulae conniventes or valves of Kerckring. These are made up of mucosal and submucosal layers with a firm connective tissue core. The majority of these folds extend for about two thirds of the circumference of the bowel cylinder and are visible on plain abdominal films of patients with obstruction.

The jejunum and ileum are supplied by the superior mesenteric artery and vein, which form the substance of the mesentery to the free small bowel. This mesentery is fan-shaped with a narrow 6-inch base attached to the posterior abdominal wall along a line down the posterior parietes from left to right from the body of the second lumbar vertebra to the sacroiliac articulation on the right. This mesentery contains blood vessels, lymphatics (lacteals), lymph nodes, nerves, and a variable amount of fat.

LYMPHATIC SUPPLY

The lymphatic supply of the small bowel is composed of the collecting vessels in the intestinal wall and mesentery, and the lacteals which follow the arterial and venous supply draining into the mesenteric nodes and eventually into the preaortic nodes. The lymphatic vessels of the duodenum drain into an anterior and posterior set situated along the pancreatico-duodenal groove. From these nodes, drainage is superiorly to those along the hepatic artery, to the subpyloric position, and inferiorly to those around the first portion of the superior mesenteric artery.

NERVE SUPPLY

The small intestine receives its nerve supply through the autonomic nervous system, which includes both afferent and efferent fibers. The latter (efferent) are both sympathetic and parasympathetic in distribution and function. Structurally the vagus nerve carries parasympathetic fibers to the small bowel via the posterior or right vagus nerve and the celiac and superior mesenteric plexus. In addition, the vagus nerve might also be a conveyor of afferent impulses. The sympathetic fibers reach the small intestine via the lesser and greater splanchnic nerves and the celiac and superior mesenteric plexuses. From these plexuses the fibers follow the superior mesenteric vessels to the bowel wall. The sympathetic fibers synapse in the abdominal ganglia from whence postganglionic fibers travel to the bowel. The parasympathetic fibers do not synapse until the plexuses of Auerbach and Meissner are reached between the circular and longitudinal muscle layers of the bowel wall and in the submucosal layer respectively.

APPLIED ANATOMY OF SMALL INTESTINE

The relationships of the junction of the second and the third portions of the duodenum to the mesentery of the transverse colon and to the head of the pancreas and vena cava are shown in Figures 1–3 and 1–4. These relationships are of importance in accomplishing Kocher's maneuver, basic to operative procedures on the duodenum and the termination of the biliary and pancreatic ducts. Note in Figure 1–3 the beginning of the dissection for the elevation of the second portion of the duodenum. This dissection stays close to the bowel wall and begins at the most inferior portion of the duodenum that is accessible before it becomes covered by the mesentery of the colon. It is necessary to use sharp dissection only over a short 2 or 3 cm. segment, since finger dissection safely completes the maneuver from right to left over the aorta and superiorly until the whole head and neck of the pancreas is in the palm of the operator's hand. Following this maneuver, the right lateral attachments of the duodenum can be severed, frequently without clamping vessels. Figure 1–4 demonstrates the exposure of the second portion of the duodenum gained by the completed Kocher maneuver and the relationships of the duodenum to adjacent structures.

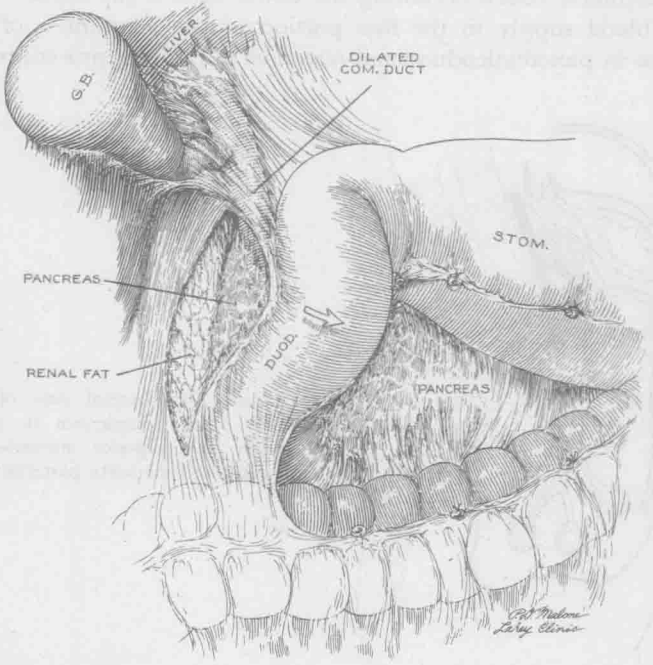

Figure 1–3. Relationships of second and third portions of the duodenum to the mesentery of transverse colon and head of pancreas. Beginning of Kocher's maneuver.

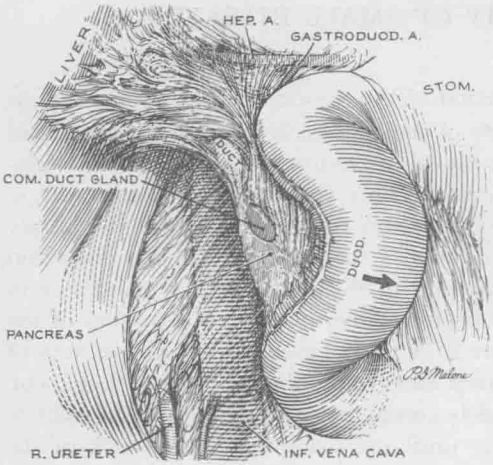

Figure 1–4. Relationships of second and third portions of the duodenum to the vena cava, spermatic vein, common bile duct, and common duct gland. Last dissection to elevate completely the second portion of the duodenum.

Figure 1–5 depicts a lateral view of the third portion of the duodenum as it passes from right to left between the aorta posteriorly and the superior mesenteric vessels anteriorly. Dilatation of the proximal duodenum with slow emptying of this portion has been ascribed to obstruction at this point by the mesenteric vessels occluding the bowel against the aorta.

The blood supply to the first portion of the jejunum is of extreme importance in pancreaticoduodenal resection or in other procedures involv-

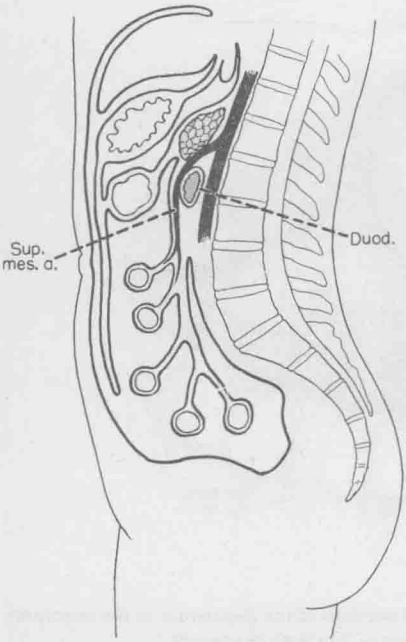

Figure 1–5. Lateral view of the third portion of the duodenum in its location between the superior mesenteric vessels anteriorly and the aorta posteriorly.

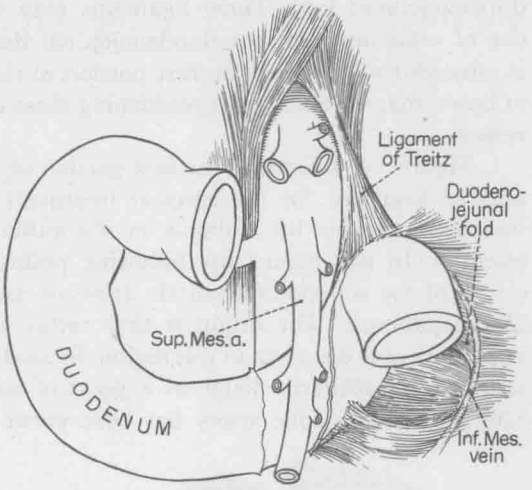

Figure 1–6. Ligaments and folds of the duodenojejunal flexure.

ing this portion of the small intestine. Figure 1–2 shows the first branches of the superior mesenteric artery to be jejunal branches that do not anastomose freely with each other and are very short. Extreme care must be exercised in resecting this portion of the jejunum and the duodenojejunal flexure so as not to compromise the blood supply, especially to the proximal segment.

Figure 1–6 shows the duodenojejunal flexure attached superiorly to the left diaphragmatic crus by the ligament of Treitz and laterally by the

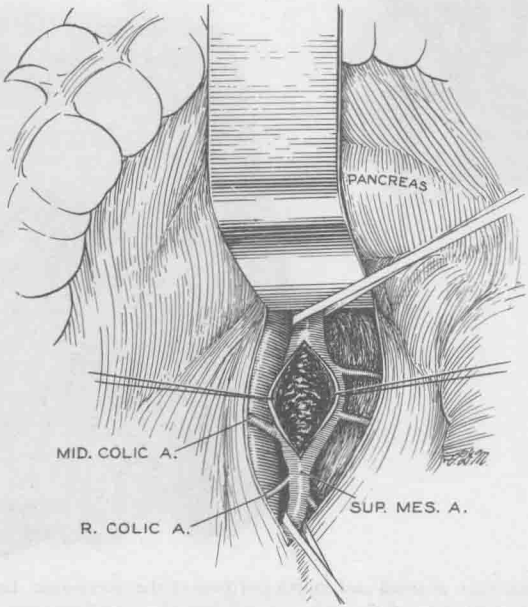

Figure 1–7. Position and branches of superior mesenteric artery relative to occlusion of this artery.

duodenojejunal fold. These ligaments may vary in length, breadth, and site of attachment to the duodenojejunal flexure; they are of importance in procedures involving the first portion of the jejunum, as essential length of bowel may be obtained by sectioning them over to the superior mesenteric vessels.

Figure 1–7 illustrates the first portion of the superior mesenteric artery and its branches. In the surgical treatment of occlusion of the superior mesenteric artery by embolus or thrombus, exposure of this region is essential. In this regard the following points are worth noting. First, the origin of the superior mesenteric artery is usually under the neck or body of the pancreas. The origin is thus rather inaccessible to direct anterior approach, as is the aorta in this region. Second, emboli to the superior mesenteric artery ordinarily lodge at a point of sudden narrowing, usually just after the middle colic artery has been given off. Thus, the artery is more

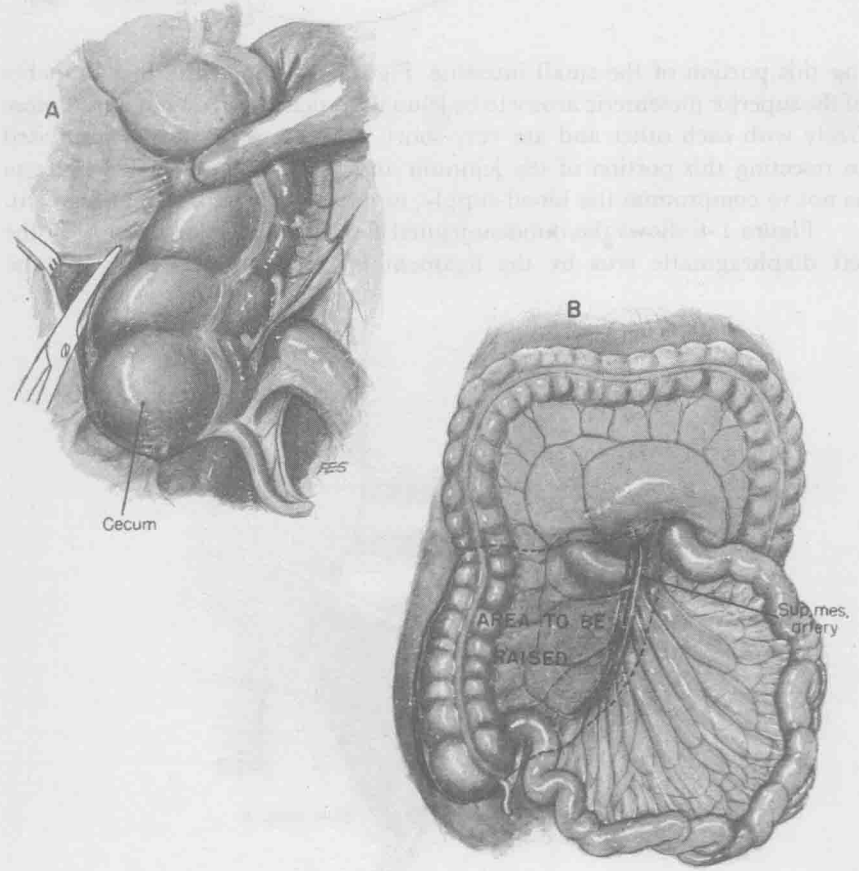

Figure 1–8. Exposure of third and fourth portions of the duodenum. Initial dissection for mobilization of the right side of the colon, small intestine, and mesentery is shown in *A*. (From Cattell, R. B., and Braasch, J. W.: Surg. Gynec. & Obst. *111*:378, 1960.)

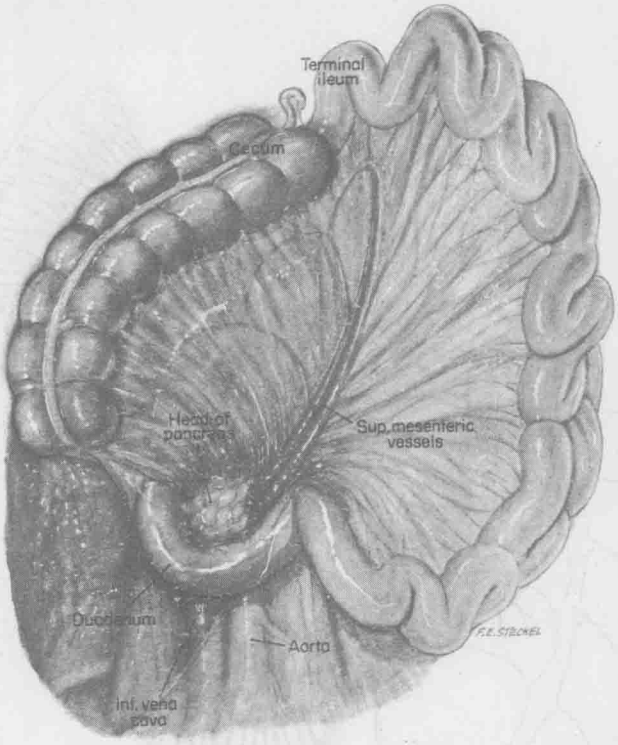

Figure 1–9. Exposure obtained of the third and fourth portions of the duodenum. (From Cattell, R. B., and Braasch, J. W.: Surg. Gynec. & Obst. *111*:378, 1960.)

readily accessible for dealing directly with embolic occlusion than for endarterectomy of the superior mesenteric artery takeoff.

The method of surgical exposure of the third and fourth portions of the duodenum is shown in Figures 1–8 and 1–9.[3] Since the mesentery of the right colon and small intestine is fused in uterine life with the posterior parietes, a line of cleavage exists which can be dissected to raise these organs and give direct access to the retroperitoneal duodenum.

Identification of a specific segment of small intestine is at times of enormous importance. Figure 1–10 and Table 1–1 indicate the differences between proximal jejunum and distal ileum. Note that the blood supply to these segments differs since the vessels to the ileum form many more arcades than those to the jejunum. The wall of the jejunum is much thicker than that of the ileum, the mesenteric fat in the ileum "creeps" up over the bowel wall for a short distance, the lumen in the ileum is smaller than in the jejunum, and the valvulae conniventes are much less marked in the ileum than in the jejunum.

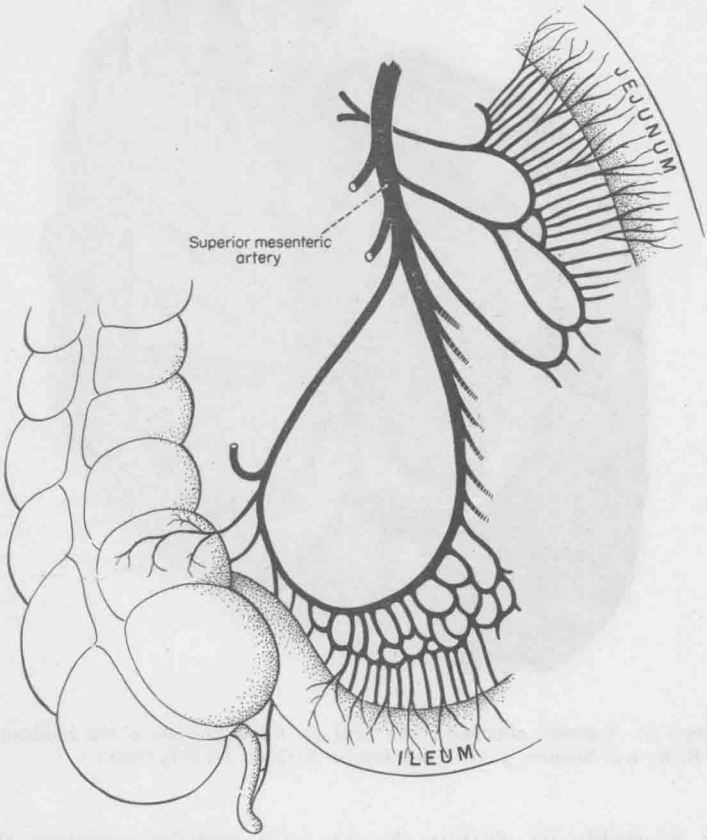

Figure 1–10. Blood supply to the jejunum and ileum. Note difference in arcades. (Adapted from Hollinshead, W. H.: Anatomy for Surgeons. New York, Paul B. Hoeber, Inc., 1956, p. 472.)

Table 1–1. Gross Differences Between Jejunum and Ileum

	JEJUNUM	ILEUM
Wall	Thick	Thin
Lumen	Large	Smaller
Mesenteric fat	On mesentery	On bowel and mesentery
Valvulae conniventes	Prominent	Less prominent
Blood supply	Single arcades	Several arcades