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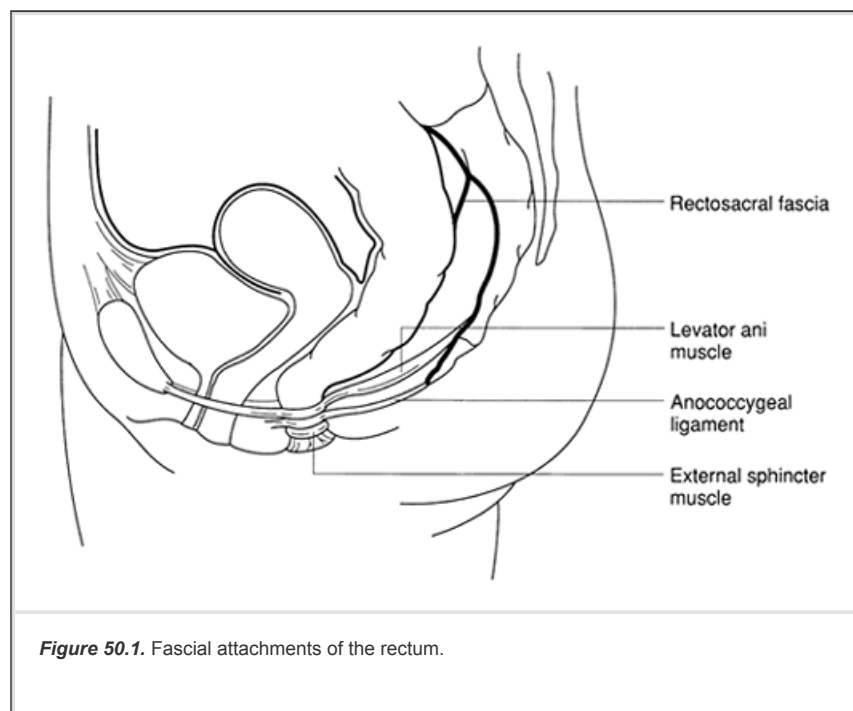
Surgery: Scientific Principles & Practice, 3rd Edition

ANATOMY OF THE RECTUM AND ANAL CANAL

Part of "CHAPTER 50 - ANORECTAL DISORDERS"

Rectum

The rectum extends from the level of the promontory of the sacrum to the level of the levator ani muscle and varies in length from 12 to 15 cm. The rectum differs from the colon in that the outer layer is covered circumferentially by longitudinal muscle rather than the three taeniae bands. The rectum has two or three lateral curves that form submucosal folds in the lumen, known as the *valves of Houston*. The posterior part of the rectum is devoid of peritoneum and is covered with the endopelvic fascia. The presacral fascia is a strong, endopelvic fascia that covers the entire anterior surface of the sacrum and also the underlying vessels and nerves. At about the level of S-4, the presacral fascia runs forward and downward and attaches to the rectum (1). This portion is referred to as the *rectosacral fascia* (Fig. 50-1). It is necessary to cut this fascia for full mobilization of the rectum, as in abdominoperineal resection or low anterior resection. Peritoneum covers the upper two thirds of the rectum anteriorly, and the upper one third of the rectum is covered by peritoneum laterally. The lower third of the rectum is entirely devoid of peritoneum. In general, the anterior peritoneal reflection is about 6 to 8 cm from the anal verge. The extraperitoneal portion of the rectum is covered by the endopelvic fascia, which, on the anterior surface, is called *Denonvilliers' fascia*. The lateral endopelvic fascia, which is thicker, is referred to as the *lateral rectal stalks*, which must also be divided for full mobilization of the rectum.



Anal Canal

The anal canal, about 4 cm in length, is the terminal portion of the large bowel that passes through the levator ani muscle and opens to the anal verge. The muscular wall of the anal canal, as a continuation of the circular muscular layer of the rectum, is thickened and forms the internal sphincter. The anal canal is wrapped by the external sphincter muscle and the puborectal muscle, which are arranged in three U-shaped loops (2). The top loop is formed by the puborectal muscle, which originates from the pubis. The intermediate loop is the superficial external sphincter muscle; the origin of this loop, at the tip of the coccyx, is known as the *anococcygeal ligament*. The basal loop is composed of the subcutaneous portion of the external sphincter muscle (Fig. 50-2).



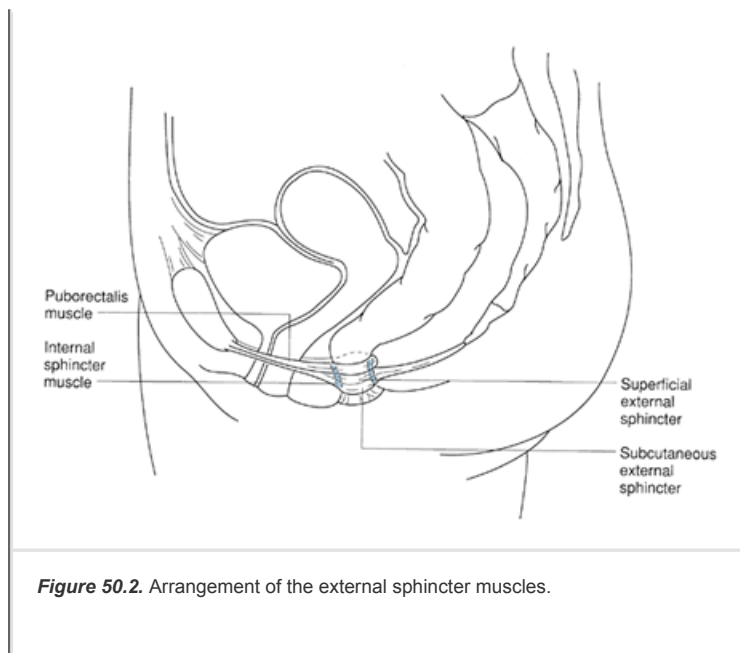


Figure 50.2. Arrangement of the external sphincter muscles.

The upper portion of the anal canal, where the internal sphincter muscle becomes thickened and the puborectal muscle wraps around (felt on digital examination of the lateral and posterior quadrants), is called the *anorectal ring*. From the level of the anorectal ring distally and between the internal and external sphincter muscles, the longitudinal muscle coat of the rectum is joined by fibers of the levator ani and puborectal muscles to form the conjoined longitudinal muscle (Fig. 50-3). These muscle

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fibers, which may traverse the lower portion of the distal external sphincter to insert in the perianal skin and cause wrinkling of the anal verge, are referred to as the *corrugator cutis ani*.

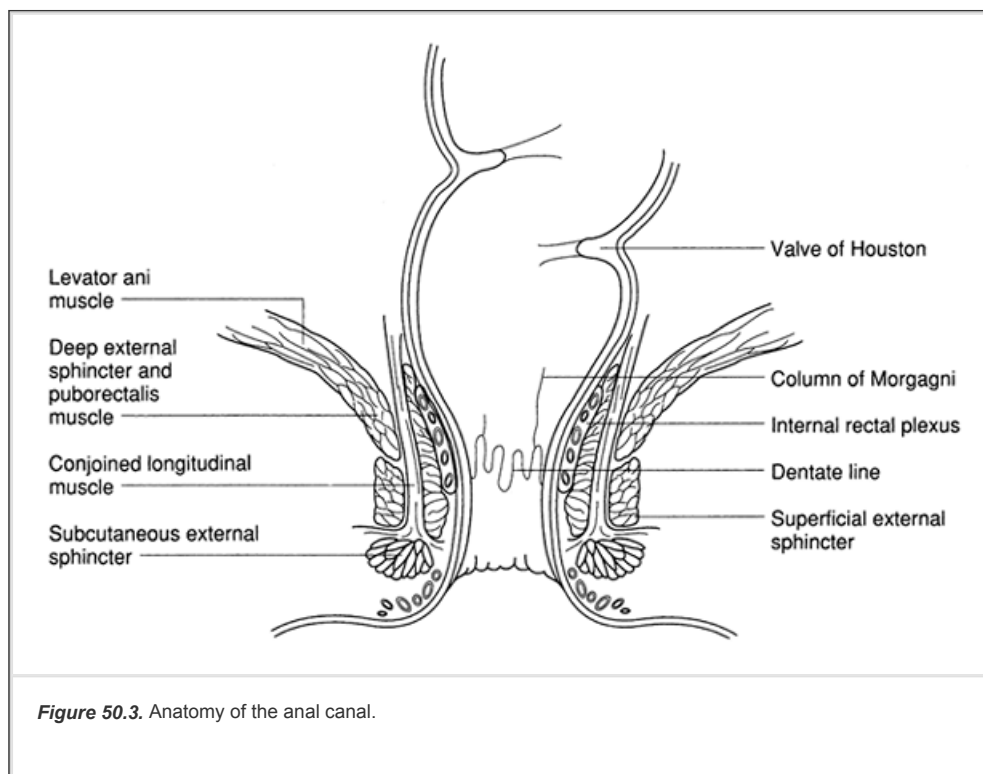


Figure 50.3. Anatomy of the anal canal.

At about the midpoint of the anal canal, 2 cm from the anal verge, is an undulating demarcation called the *dentate* or *pectinate line*. Longitudinal folds of the mucosa above the dentate line are known as the *columns of Morgagni*. For a distance of about 1 cm above the dentate line, the epithelial lining may be columnar, transitional, or stratified squamous epithelium; this area is referred to as the *transitional* or *cloacogenic zone*. The area above the transitional zone is lined by columnar epithelium, and the area below the dentate line is lined by squamous epithelium (Fig. 50-3). This is also the area where the internal hemorrhoidal plexus lies.

Pelvic Floor Muscles

The pelvic floor muscles consist of the levator ani and the iliococcygeal muscle. The levator ani is a broad, thin muscle that forms the floor of the pelvic cavity and is innervated by the fourth sacral nerve. This muscle has traditionally been considered to consist of three muscles—iliococcygeal, pubococcygeal, and puborectal. Studies suggest that it consists only of the iliococcygeal and pubococcygeal muscles, and that the puborectal muscle is actually

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a part of the deep portion of the external sphincter (3,4).

The iliococcygeal muscle arises from the ischial spine and posterior part of the obturator fascia; it passes downward, backward, and medially and inserts on the last two segments of the sacrum and the anococcygeal raphe (Fig. 50-4). The pubococcygeal muscle arises from the anterior half of the obturator fascia and the back of the pubis. The fibers of the pubococcygeal muscle are directed backward, downward, and medially, where they decussate with fibers of the opposite side. The line of decussation is called the *anococcygeal raphe* (Fig. 50-4). Some fibers that lie more posteriorly are attached directly to the tip of the coccyx and the last segment of the sacrum. This muscle also contributes fibers to the conjoined longitudinal muscle. The puborectal and levator ani muscles have reciprocal actions; as one contracts, the other relaxes. During defecation, puborectal relaxation is accompanied by levator ani contraction, which widens the hiatus and elevates the lower rectum and anal canal. When a person is in an upright position, the levator ani muscle supports the viscera.

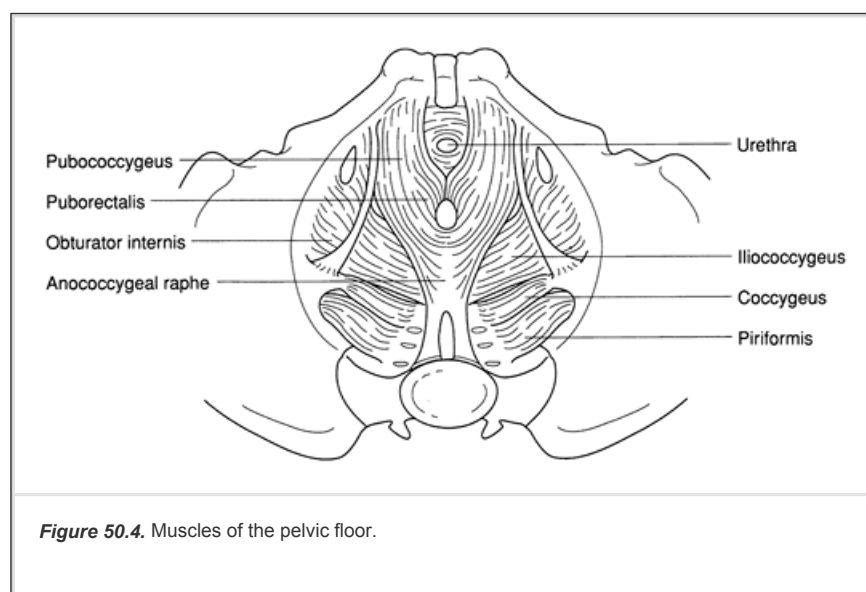


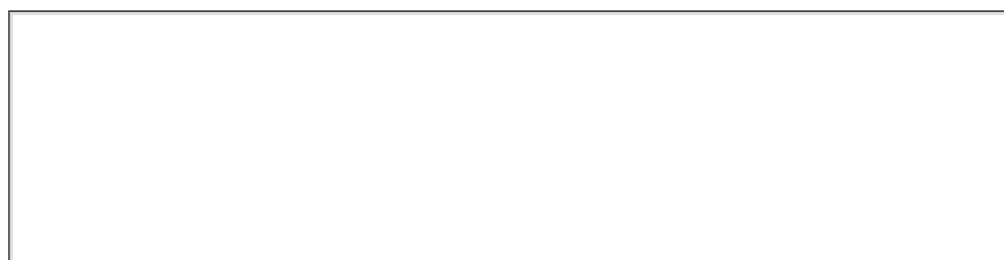
Figure 50.4. Muscles of the pelvic floor.

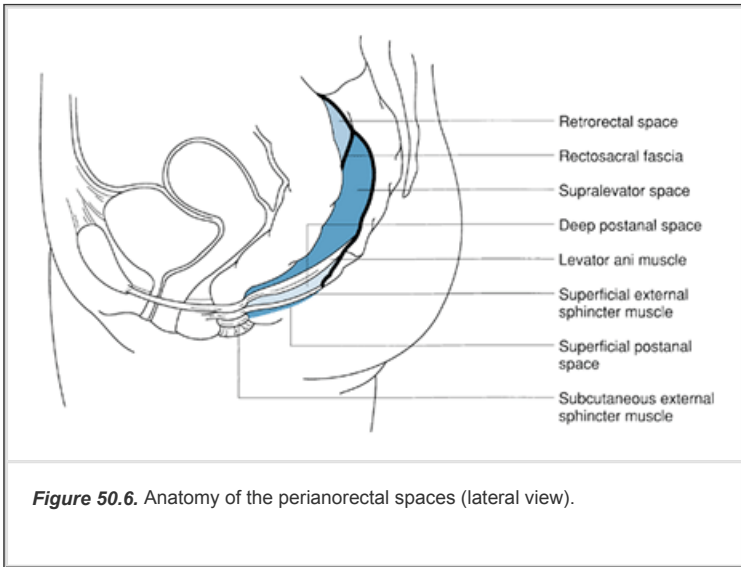
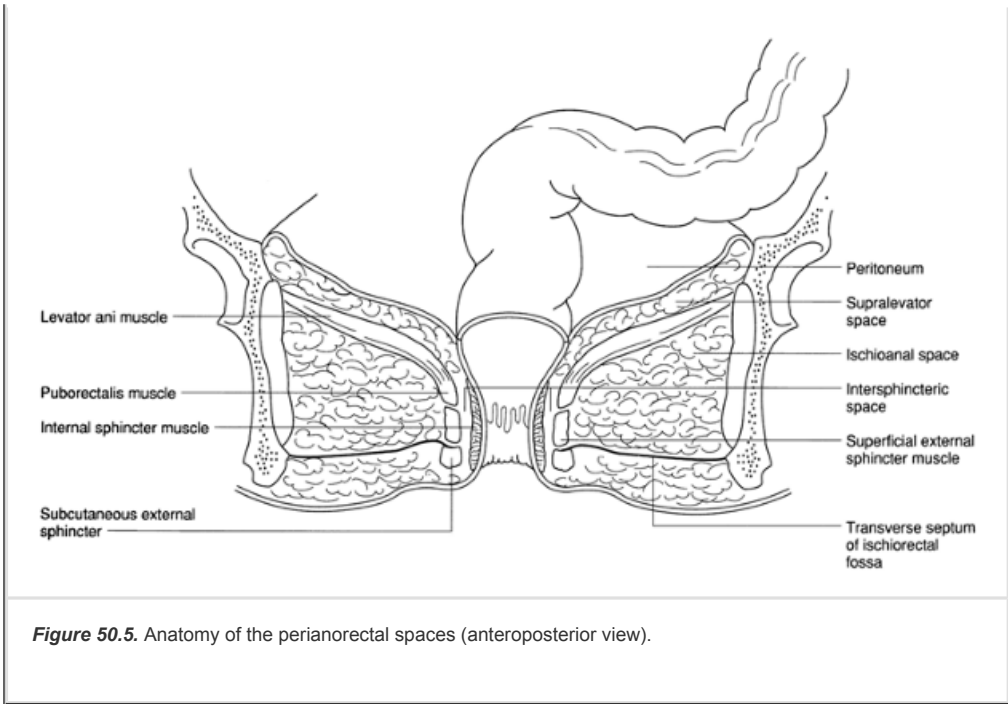
Perianal and Perirectal Spaces

Surrounding the anorectum are several potential spaces that are normally filled with areolar tissues or fat. These spaces are clinically important because they are sites where abscesses can form. The perianal space immediately surrounds the anus. Laterally, the perianal space is contiguous with the subcutaneous fat of the buttocks. Medially, it is bound by the anoderm to the level of the dentate line. The ischioanal space is a triangular region below the

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levator ani muscle, bound medially by the external sphincter muscle, laterally by the ischium, and inferiorly by the transverse septum of the ischioanal fossa (Fig. 50-5). The ischioanal space on each side is filled with fat and contains the inferior rectal vessels and lymphatics. The deep postanal space connects the ischioanal space on each side posteriorly and lies between the levator ani muscle above and the anococcygeal ligament below (Fig. 50-6). The deep postanal space is an important pathway in the formation of abscess; spread from one ischioanal fossa to the other may result in a so-called horseshoe abscess. The intersphincteric space lies between the internal and external sphincter muscles. It is continuous with the perianal space below and extends above into the wall of the rectum. The supralelevator spaces are situated on each side of the rectum above the levator ani (Fig. 50-5). The supralelevator spaces communicate posteriorly and may allow spread of infection cephalad into the retroperitoneum (Fig. 50-6).





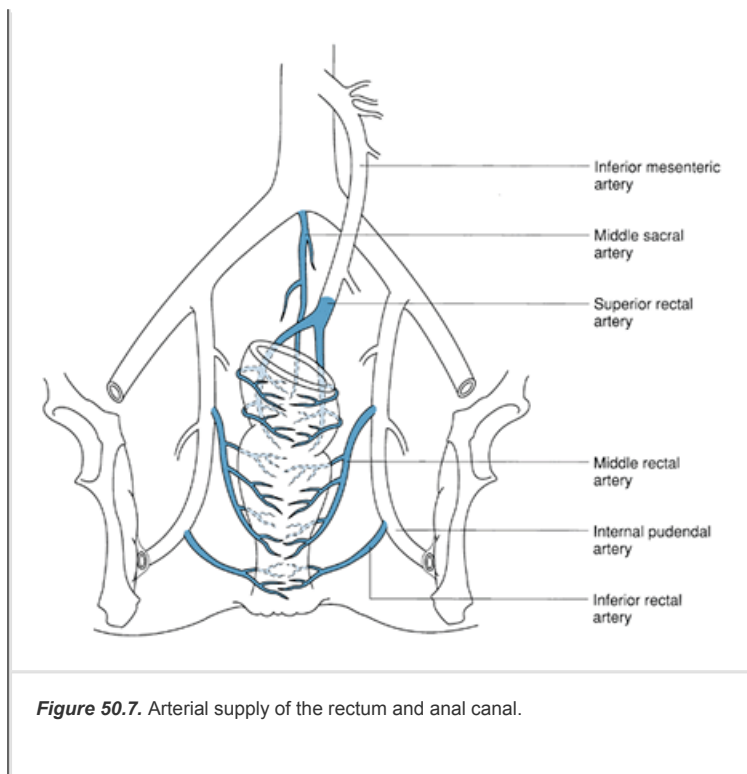
Arterial Supply of the Rectum and Anal Canal

The superior rectal (hemorrhoidal) artery is a continuation of the inferior mesenteric artery; it descends posteriorly to the rectum, where it bifurcates to supply the rectum and upper portion of the anal canal (Fig. 50-7). The middle

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rectal (hemorrhoidal) arteries arise from the internal iliac artery on each side and enter the lower portion of the rectum anterolaterally at variable points but usually in the lower third of rectum. The middle rectal arteries are inconsistent and cannot be relied on after ligation of the superior rectal artery. The inferior rectal (hemorrhoidal) arteries arise from the internal pudendal artery, a branch of the internal iliac artery, and traverse the ischioanal fossa on each side to supply the anal sphincter muscles. Although no extramural anastomoses between the superior rectal artery, middle rectal artery, and inferior rectal artery are seen on cadaver dissection, arteriography shows abundant intramural anastomoses between them, particularly in the lower rectum. The middle sacral artery supplies an insignificant amount of blood to the rectum. It arises posteriorly, just above the bifurcation of the aorta, and descends over the lumbar vertebrae, sacrum, and coccyx.





Venous Drainage of the Rectum and Anal Canal

Blood returns from the rectum and anal canal through two systems—portal and systemic (Fig. 50-8). The superior rectal (hemorrhoidal) vein drains the rectum and upper part of the anal canal into the portal system through the inferior mesenteric vein. The middle rectal veins drain the lower part of the rectum and upper part of the anal canal; they accompany the middle rectal arteries and terminate in the internal iliac veins. The inferior rectal veins, following the corresponding arteries, drain the lower part of the anal canal by way of the internal pudendal veins, which empty into the internal iliac veins.

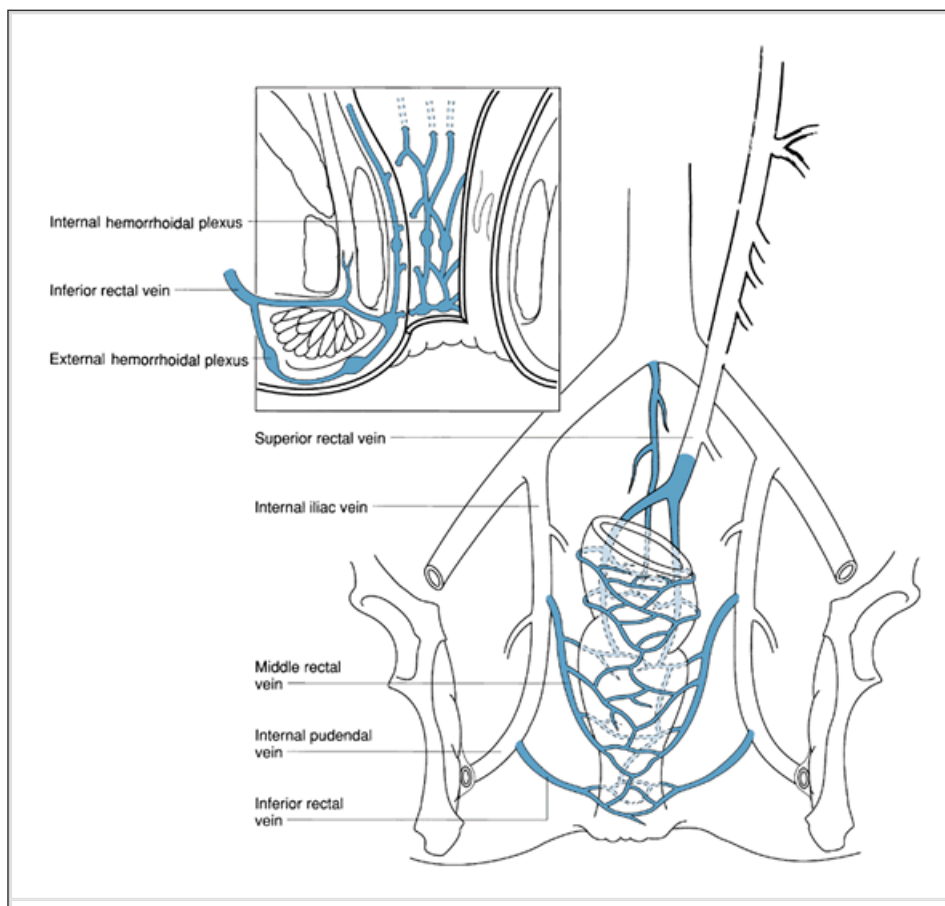


Figure 50.8. Venous drainage of the rectum and anal canal.

Lymphatic Drainage of the Rectum and Anal Canal

Lymph from the upper and middle portions of the rectum ascends along the superior rectal artery and subsequently to the inferior mesenteric lymph nodes. The lower part of the rectum drains cephalad by way of the superior rectal lymphatics to the inferior mesenteric nodes, and laterally by way of the middle rectal lymphatics to the internal iliac nodes (Fig. 50-9). Lymphatics from the anal canal above the dentate line drain cephalad through the superior rectal lymphatics to the inferior mesenteric nodes, and laterally along both middle rectal vessels and inferior rectal vessels through the ischioanal fossa to the internal iliac nodes. Lymph from the anal canal below the dentate line

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usually drains to the inguinal nodes, although it can also drain to the superior rectal lymph nodes or along the inferior rectal lymphatics to the ischioanal fossa if the primary drainage is obstructed (Fig. 50-10). Retrograde lymphatic spread of carcinoma of the rectum and anal canal occurs only in cases of extensive involvement of the perirectal structures, serosal surfaces, veins, and perineural lymphatic and proximal lymphatic channels (5).

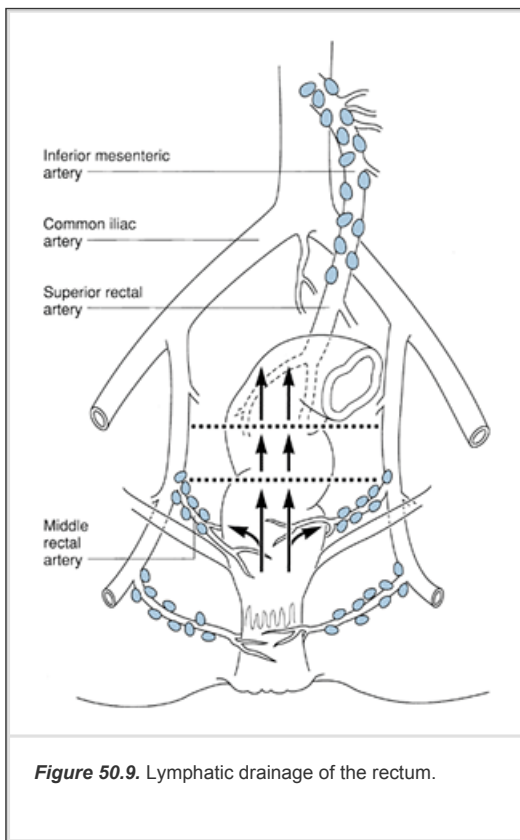


Figure 50.9. Lymphatic drainage of the rectum.

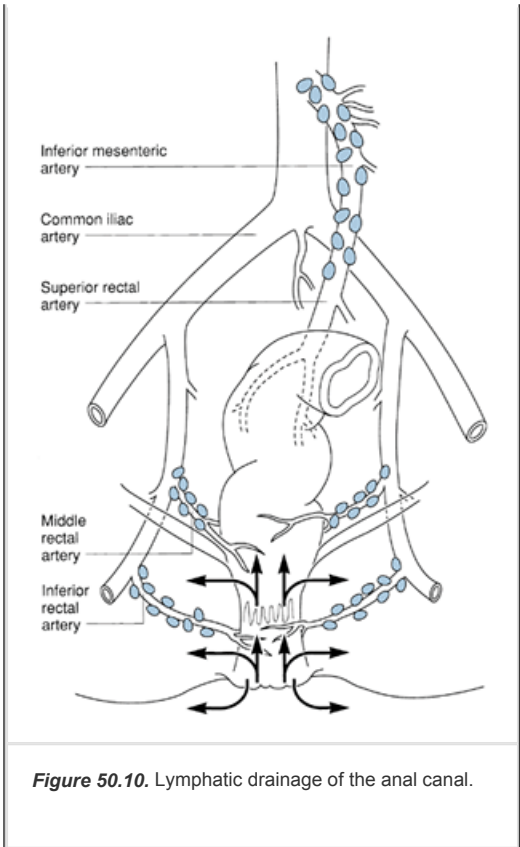


Figure 50.10. Lymphatic drainage of the anal canal.

Nerve Supply of the Rectum and Urogenital Organs

Sympathetic and parasympathetic nerves of the autonomic nervous system supply the anorectum and also send branches to the adjacent urogenital organs. Nerve trunks are close to the rectum and are prone to injury during mobilization of the rectum unless specific precautions are taken.

Sympathetic nerve fibers to the rectum are derived from the first three lumbar segments of the spinal cord. Sympathetic fibers pass through ganglionated sympathetic chains before forming the preaortic plexus. Preaortic fibers extend below the bifurcation of the aorta to form the hypogastric plexus or the presacral nerve (Fig. 50-11). The plexus thus formed divides into left and right branches on each side of the pelvis, where they are joined by the parasympathetic nerves.

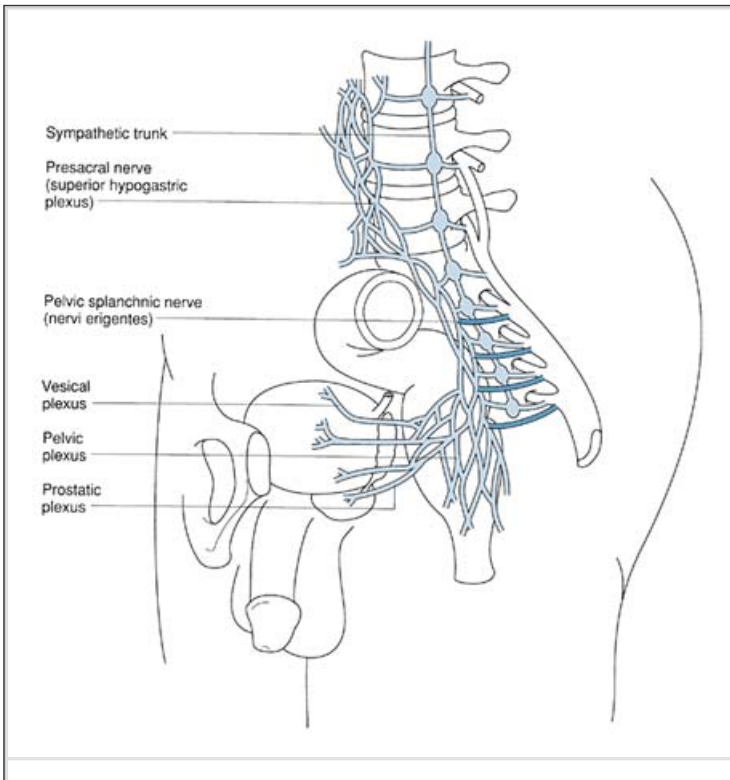


Figure 50.11. Sympathetic and parasympathetic nerve supply of the rectum.

The pelvic parasympathetic nerve supply is from the nervi erigentes, which originate from the second, third, and fourth sacral nerve roots. The fibers pass inward and forward to join the sympathetic nerve fibers and form the pelvic plexus. The pelvic plexus on each side is encased in the midportion of the lateral stalk, which is located just above the levator ani muscle (Fig. 50-11). From each pelvic, both types of nerve fibers are distributed to urinary and genital organs.

In women, the sympathetic nerve fibers from the hypogastric plexus are directed toward the uterosacral ligament close to the rectum. In men, the nerve fibers from the hypogastric plexus pass immediately adjacent to the anterolateral wall of the rectum in the retroperitoneal tissue.

The pelvic plexus gives rise to the periprostatic plexus, an important subdivision that is essential to sexual function in men. The periprostatic plexus distributes fibers to the prostate, seminal vesicles, corpora cavernosa, terminal part of the vas deferens, prostatic and membranous urethra, ejaculatory ducts, and bulbourethral glands. Both parasympathetic and sympathetic nervous systems are involved in erection. Nerve impulses from the parasympathetic nerves, which lead to erection, produce vasodilation and increase blood flow in the cavernous spaces of the penis. Activity of the sympathetic system adds to vascular engorgement and sustained erection. Moreover, sympathetic activity causes contraction of the ejaculatory ducts, seminal vesicles, and prostate, with subsequent expulsion of semen into the posterior urethra. Depending on which nerves have been damaged, deficiencies may include incomplete erection, lack of ejaculation, retrograde ejaculation, or total impotence (6).

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The following precautions can be exercised during operations on the pelvic colon to avoid nerve injuries:

1. When mobilizing the rectosigmoid colon and upper rectum for nonmalignant disease, dissect close to the bowel wall posteriorly and do not disturb the retroperitoneal tissue, to avoid injury to the hypogastric plexus.
2. Cut the peritoneum on each side close to the rectum and brush off the retroperitoneal tissue laterally to avoid injury to the left and right branches of the hypogastric plexus.
3. Divide the lateral stalks close to the rectum to avoid injury to the nervi erigentes and the pelvic plexus.
4. Note that the bulk of the pelvic plexus is lateral and posterior to the seminal vesicles (7). Separation of the rectum from the seminal vesicle should start at the midline. This is carried laterally to the edge of the seminal vesicle, then curves inferiorly to avoid injury to the neurovascular bundle.

The pudendal nerve arises from the sacral plexus (S-2 to S-4). It leaves the pelvis through the greater sciatic foramen, crosses the ischial spine, and then continues in the pudendal canal toward the ischial tuberosity in the lateral wall of the ischioanal fossa on each side. Three of its important branches are the inferior rectal, perineal, and dorsal nerves of the penis or clitoris. The pudendal nerve is anatomically protected from injury during mobilization of the rectum. Sensory stimuli from the penis and clitoris are mediated by a branch of the pudendal nerve and thus are preserved after proctectomy.

Nerve Supply of the Anal Canal

Motor Innervation

The internal sphincter is supplied by both sympathetic and parasympathetic nerves. The sympathetic and parasympathetic nerves inhibit the internal anal sphincter. The external sphincter is supplied by the inferior rectal branch of the internal pudendal nerve and the perineal branch of the fourth sacral nerve. The levator ani is supplied not only by the pudendal nerve but also by direct branches of the third, fourth, and often the fifth sacral nerves, the fifth lying above the pelvic floor.

Sensory Innervation

The sensory nerve supply of the anal canal comes from the inferior rectal nerve, a branch of the pudendal nerve. The epithelium of the anal canal is profusely innervated with sensory nerve endings, especially in the vicinity of the dentate line. Painful sensations in the anal canal can be felt at sites up to 1.5 cm proximal to the dentate line.