Anatomy of the rectum and anal canal

Peter J Bazira

Abstract

The rectum and anal canal are the terminal portions of large intestine and the entire gastrointestinal tract. They are thus readily accessible to direct inspection and examination. The rectum functions as a distensible reservoir for faeces, while the anal canal possesses a powerful muscular sphincter in its wall which is important in maintaining faecal continence. Diseases of the rectum and anal canal, both benign and malignant, account for a very large part of colorectal surgical practice worldwide. This article emphasizes the clinically and surgically relevant aspects of the anatomy of the rectum and anal canal.

Keywords Anal cushions; anal sphincters; inferior hypogastric plexus; lymphatic drainage; mesorectum; perineum; rectal blood supply

Introduction

The rectum and anal canal are the most distal (terminal) portions of the large intestine. The rectum is the direct continuation of the sigmoid colon. It commences in front of the body of the third sacral vertebra and runs along the anterior concavity of the sacrum (forming the 'sacral flexure') to reach the levator hiatus where it is continuous with the anal canal at the anorectal junction. The anorectal junction is located anterior to the coccyx and the levator hiatus is the gap in the pelvic floor between the two levator ani muscles through which the pelvic viscera pass inferiorly into the perineum.

The rectum

The rectum is entirely located within the pelvis, lying above the level of the pelvic floor and below the level of the pelvic brim (Figure 1). In the adult, the rectum is between 10 cm and 14 cm in length. On its external aspect, in addition to the sacral flexure, there are three, smooth, laterally facing curves. The upper and lower curves are directed to the right and the middle curve to the left (Figure 1). On the interior aspect of the rectum, each of the three external curves terminates in a transverse, sickle-shaped fold (three folds, therefore) known as the '*rectal shelves*' or '*valves of Houston*'. These rectal shelves are produced by the thickened muscle in the rectal wall projecting inwards with overlying mucosa. The middle rectal shelf is the most constant and prominent of the three shelves, and a useful landmark during sigmoidoscopy. The inferior third of the rectum is dilated and is termed the ampulla (Figure 1). Note that the key external anatomical features, haustrations, appendices epiploicae, and taeniae coli, which are characteristic of the sigmoid colon and other segments of the colon are absent on the rectum. This abrupt change in external appearance enables the identification of the rectosigmoid junction.[1–3] The rectosigmoid junction is approximately 6 cm below the level of the sacral promontory. Approached from the distal end, however, as when performing a rigid or flexible sigmoidoscopy, the rectosigmoid junction is seen to be 14–18 cm from the anal verge.

Learning point

The rectum does not possess either appendices epiploicae, haustrations, or taeniae coli.

The posterior aspect of the rectum is entirely free of a peritoneal covering, and like the ascending and descending segments of the colon, is thus retroperitoneal. However, there is a more nuanced relationship between the peritoneum and the upper, middle, and lower thirds of the rectum. The upper third of the rectum is covered by peritoneum on its anterior and lateral surfaces. The middle third of the rectum is covered by peritoneum only on its anterior surface while the lower third of the rectum is below the level of the peritoneal reflexion (the level at which the peritoneum leaves the anterior rectal wall to reach the organ anterior to it) and consequently has no peritoneum covering any of its surfaces.

Learning point

The rectum is only covered by peritoneum on the anterior and lateral surfaces of its upper third and the anterior surface of its middle third.

The middle rectal shelf, described above, is a convenient and fairly accurate indicator of the level of peritoneal reflexion.[1–3] The relationship of the peritoneum to the rectum is readily appreciated at operation for rectal cancers once the peritoneum on either side of the rectum is incised longitudinally and the rectum is straightened prior to its mobilization and eventual excision.

Fascial coverings of the rectum

Most of the rectum is surrounded by perirectal fat, which is generally more abundant posteriorly than anteriorly. The epirectal and pararectal lymph nodes as well as the superior rectal blood vessels are located within the perirectal fat. The perirectal fat is surrounded by a distinct circumferential fascial layer called the fascia propria of the rectum. The fascia propria enclosing the perirectal fat with the contained lymph nodes is referred to as the '*mesorectum*'.[1,4] The term does not imply that the rectum possesses a suspensory mesentery. However, it is a very important principle of rectal cancer surgery that for a successful outcome, the rectum must be removed with a completely intact mesorectum.

Learning point

The term mesorectum describes the perirectal fat, lymphatic tissue, and the surrounding fascia propria of the rectum.

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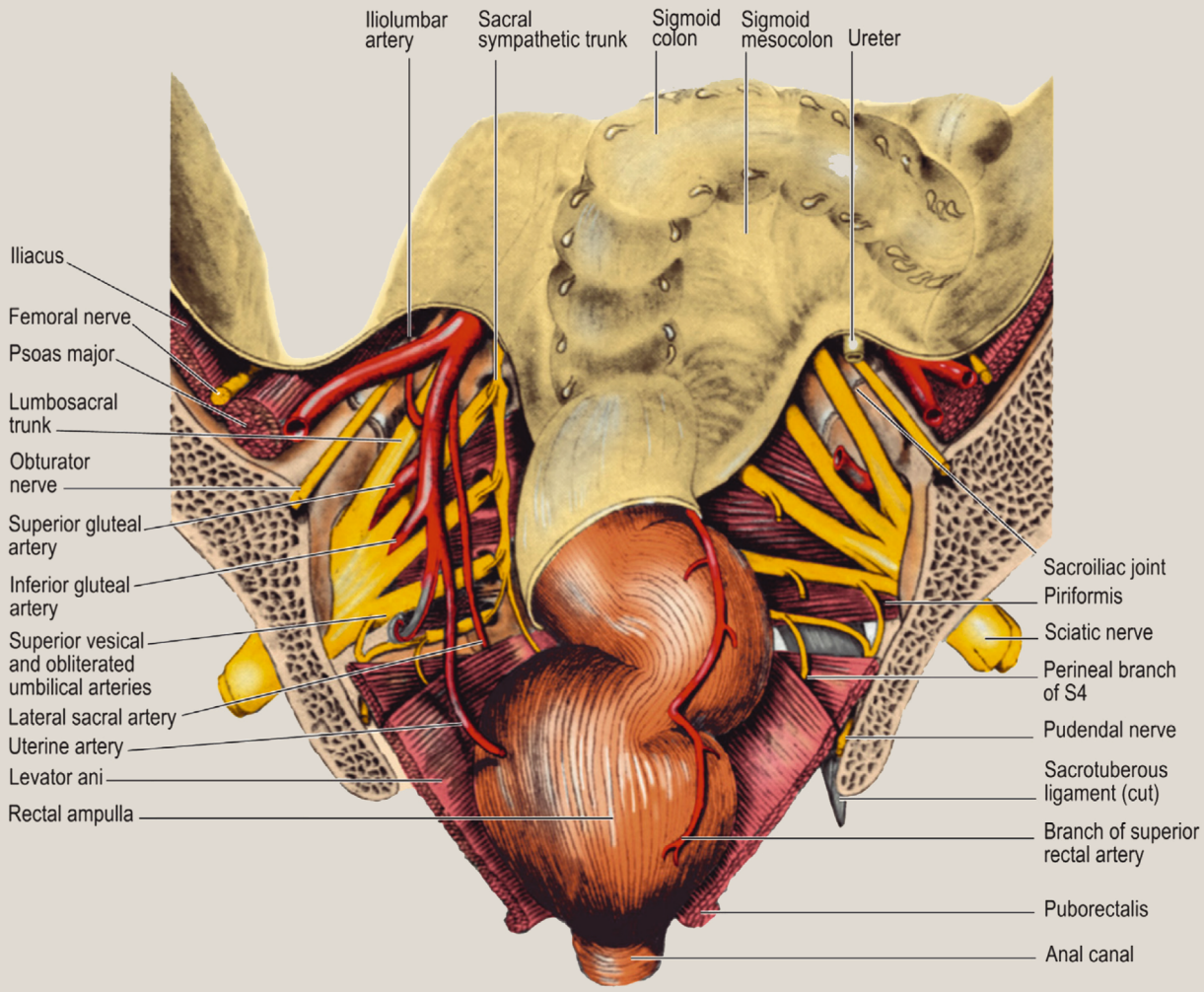
Coronal view of the posterior pelvic cavity, showing the anterior aspect of the rectum



Source: From Mahadevan, V., 2020. Anatomy of the rectum and anal canal. Surgery (Oxford), 38(1), pp.7–11. https://doi.org/10.1016/j.mpsur.2019.10.016

Figure 1

Arterial supply and venous drainage of the rectum

Arterial supply

The superior rectal artery, the direct continuation of the inferior mesenteric artery when it crosses the pelvic brim, is the main arterial supply to the rectum. It enters the perirectal fat behind the rectum and breaks up into two or three longitudinal vessels which travel on either side of the rectum before sinking into the rectal wall (Figure 2).

Other arteries which contribute to the blood supply of the rectum are the middle and inferior rectal arteries (Figure 2) and the median sacral artery.[1,3,5] The middle rectal arteries arise bilaterally from the corresponding internal iliac artery and run inferomedially just above the pelvic floor to reach the rectum. The middle rectal arteries are not usually prominent vessels and may be absent on one or both sides.

Learning point

The superior rectal artery supplies most of the arterial blood to the rectum. The middle rectal, inferior rectal, and median sacral arteries only supplement this supply.

The inferior rectal arteries are given off as branches of the corresponding internal pudendal artery upon its entry into the perineum. The inferior rectal artery crosses the ischioanal fossa from lateral to medial to enter the anal wall and forms the main arterial supply to the anal canal. However, it also contributes to the supply of the distal third of the rectum.

The median sacral artery arises from the posterior aspect of the aorta just proximal to the aortic bifurcation and runs

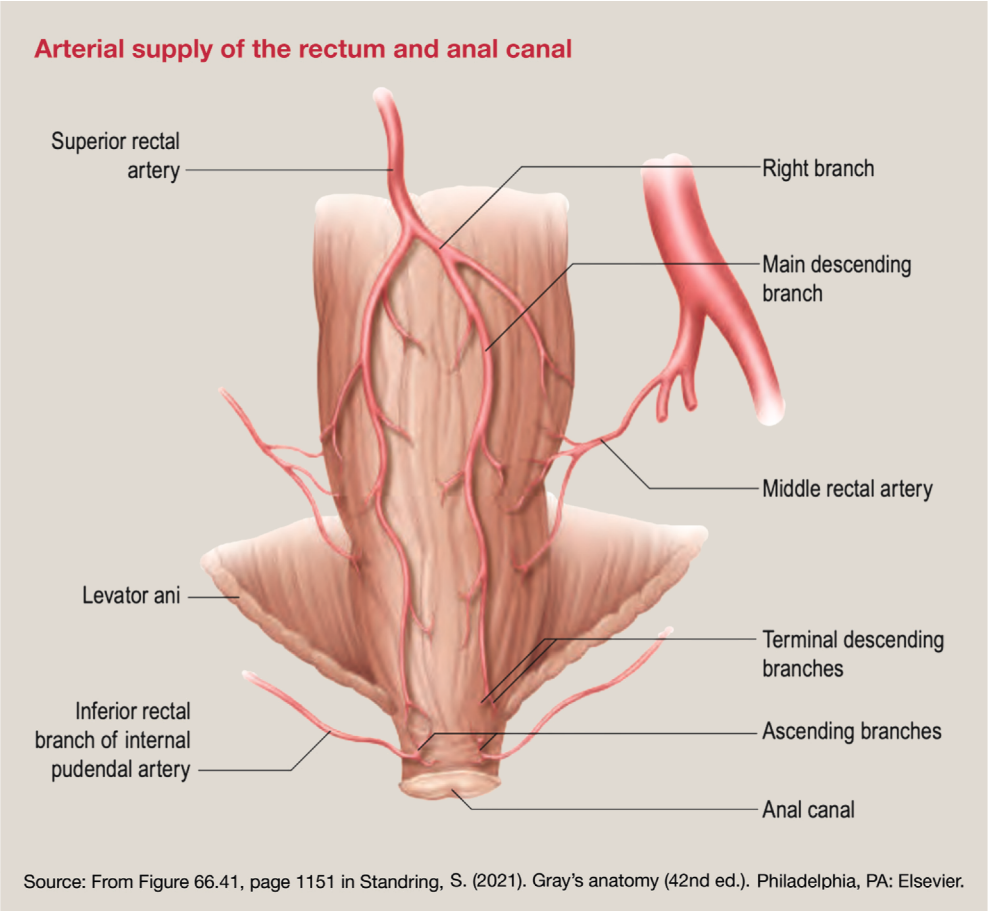


Figure 2

inferiorly on the anterior aspect of the sacrum. Upon reaching the pelvic floor, the median sacral artery runs anteriorly to terminate in and supply the rectal wall. The contribution of this artery to the blood supply of the rectum is trivial.

Venous drainage

The venous drainage of the rectum mirrors the arterial supply.[1,3,5] Venous blood from the rectal wall drains into a rich and valveless intramural venous plexus blood and passes into an equally valveless perirectal venous plexus. The perirectal venous plexus drains bilaterally into the superior rectal veins.

The superior rectal veins cross the pelvic brim from below upwards to become the inferior mesenteric vein. Thereafter the inferior mesenteric vein drains the sigmoid colon, descending colon, and splenic flexure before emptying into the splenic vein and thereby into the hepatic portal vein.

Learning point

The valveless intramural and perirectal venous plexuses primarily drain rectal venous blood to the inferior mesenteric vein and less so to the internal iliac veins.

Some venous blood from the intramural and perirectal venous plexuses travels bilaterally in the middle rectal veins and drains into the internal iliac veins. Venous blood from these rectal plexuses may also find its way through the anal wall into the inferior rectal veins which drain into the internal iliac veins via the internal pudendal veins.

The anal mucosa and submucosa are therefore sites of portosystemic venous anastomoses. These anastomoses are also present to a limited extent in the rectal wall. In portal hypertension these anastomoses may become varicose (haemorrhoids), and if ruptured, may give rise to life-threatening rectal bleeding.

Lymphatic drainage of the rectum

As with the lymphatic drainage of the rest of the large intestine, rectal lymph is initially received by the lymphoid follicles in the mucosa. Thereafter, the lymph passes successively through three tiers of mesorectal lymph nodes, equivalent to the epicolic, paracolic and intermediate nodes of the colon, before reaching the so-called principal nodes (Figure 3). For the TNM (tumour, node, metastasis) cancer classification, the lymph nodes are divided into those close to the rectal wall (N1) and those more centrally placed, but still within the mesorectum (N2).[6,7]

The inferior mesenteric lymph nodes, situated around the origin of the inferior mesenteric artery, are the principal lymph

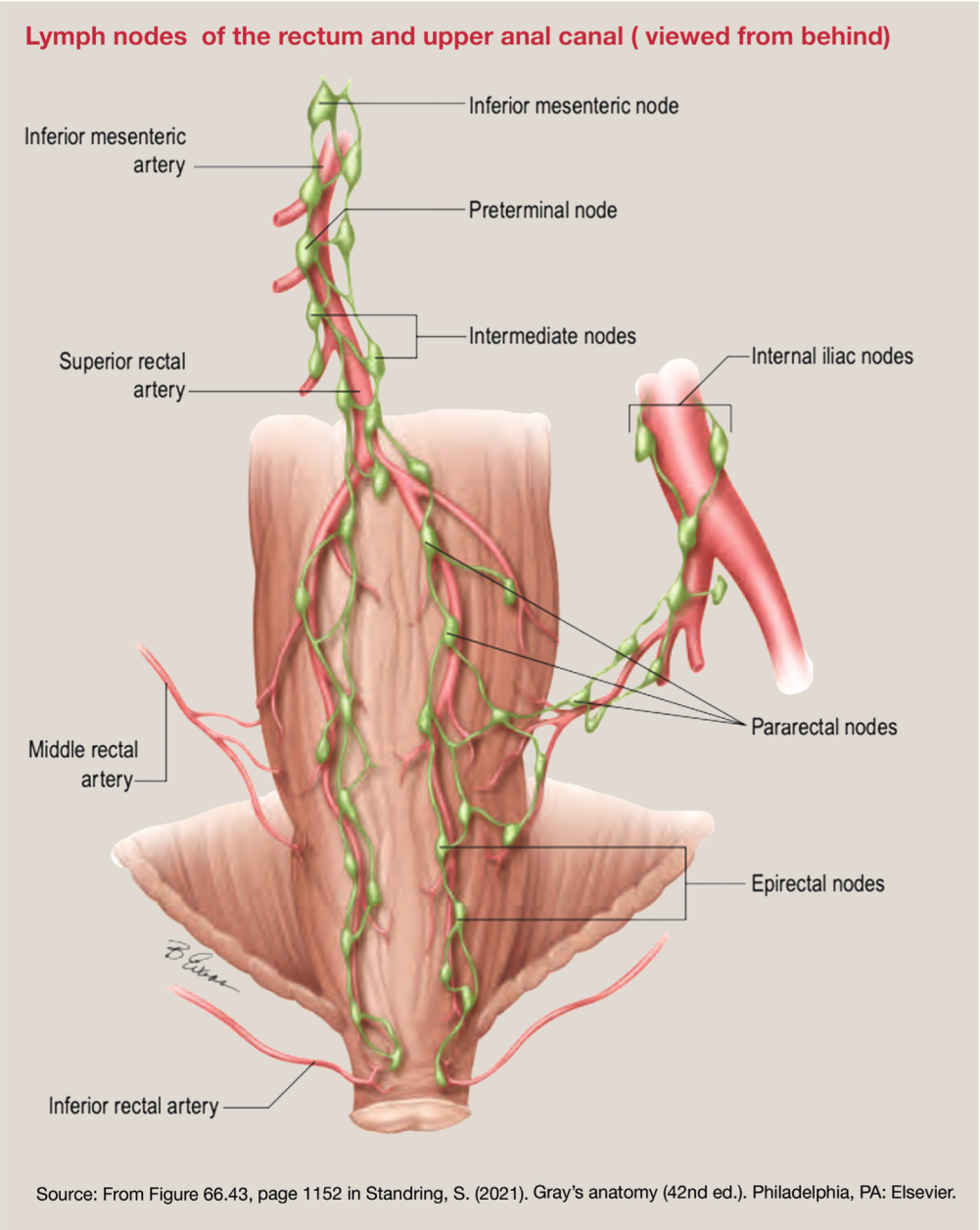


Figure 3

nodes that receive most of the lymph from the upper two-thirds of the rectum (Figure 3). Lymph from the lower third of the rectum drains into three sets of principal nodes; the inferior mesenteric lymph nodes and the internal iliac lymph nodes bilaterally (also called the pelvic side wall nodes).

Topographical relations of the rectum

Posteriorly

On its posterior aspect, the rectum is related to i) the ventral surface of the lower half of the sacrum and the adjoining coccyx, and ii) the presacral space containing the median sacral vessels and the presacral venous plexus.[1,2]

The lumbosacral nerve plexus and piriformis muscle lie posterolaterally on either side of the rectum (Figure 1). The piriformis muscle and lumbosacral plexus are covered anteriorly by a dense layer of pelvic fascia.

The anococcygeal raphe (the midline anteroposterior interdigitation of the two levator ani muscles which extends from the tip of the coccyx to the posterior aspect of the anorectal junction) lies posteroinferior to the rectum.

Laterally

Lateral to the rectum on either side lies a condensation of pelvic fascia called the lateral ligament which extends from the lateral wall of the pelvis to the rectum.[1,2] Rectal blood vessels, nerve fibres, and lymphatic vessels generally traverse the lateral ligament on their way to and from the rectum. The lateral ligament must be divided to allow full mobilization of the rectum during

its resection. A very important lateral relation of the rectum on either side is the ipsilateral inferior hypogastric plexus, a mixed autonomic nerve plexus, carrying both sympathetic and parasympathetic fibres. The inferior hypogastric plexus is an elongated, neural mesh situated outside the rectal fascia propria, which provides all the parasympathetic and most of the sympathetic innervation to the pelvic and perineal viscera. Much of the distressing morbidity associated with radical surgery for cancers of the rectum, prostate and cervix uteri is due to inadvertent disruption of these important plexuses, and manifests as bladder dysfunction in both sexes and as erectile and/or ejaculatory dysfunction in males.

Learning point

The inferior hypogastric plexuses lie lateral to the rectum and supply it with autonomic innervation.

Anteriorly

In the female, the rectum below the level of the peritoneal reflexion is related to the posterior wall of the intrapelvic vagina.[1–3] Above the peritoneal reflexion the rectum is related to the rectouterine pouch or pouch of Douglas, which is interposed between the rectum and the posterior vaginal fornix. Above the vaginal fornix the rectum is related to the posterior surface of the body of the anteverted uterus. Between the anterior aspect of the rectum and the posterior wall of the uterus there are frequently loops of small bowel, usually ileum.

In the male, the rectum below the peritoneal reflexion is related to the posterior surface of the urinary bladder, the posterior aspects of the right and left seminal vesicles, the inferior parts of the two ureters, the right and left vas deferens crossing in front of the corresponding ureter behind the bladder wall, and below the bladder neck the posterior surface of the prostate.

Learning point

The anterior relations of the rectum differ in the male and female pelvis but primarily consist of the respective internal genitalia.

All the above-named urogenital structures in the male are separated from the fascia propria of the rectum by a distinct and strong fascial layer known synonymously as *rectovesical fascia*, *rectovesical septum*, or the *fascia of Denonvilliers*.[4]

Above the peritoneal reflexion, lying in front of the upper two-thirds of the rectum, are loops of small bowel and possibly the free, lower end of the greater omentum.

The anal canal

The anal canal (Figures 1 and 4) is the most distal/terminal segment of the alimentary tract and commences at the levator hiatus as the direct continuation of the rectum. It is about 4–5 cm in the adult with a slightly longer posterior wall than the anterior.

The anal canal is located entirely below the level of the pelvic floor in the perineum. Externally, the anal canal is in the anal triangle of the perineum flanked by the right and left ischioanal (ischiorectal) fossae (Figure 4).

At its commencement, the anal canal passes downwards and backwards forming an acutely angled bend at the anorectal junction called the perineal flexure. The perineal flexure is produced by the forward pull of the sling-like puborectalis muscle, the most medial portion of the levator ani muscles. The angulation of the perineal flexure is important to remember in sigmoidoscopy as the sigmoidoscope lying in the anal canal points directly at the umbilicus, but once past the flexure it points back at the sacral hollow.

Internal appearance of the anal canal

On proctoscopy, the mucous membrane of the anal canal can be seen to possess a circumferential wavy fold about half-way up the anal canal.[1–3] This important landmark, more obvious in children and young adults than it is in the elderly, is referred to as the dentate line or pectinate line.

The upper half of the anal canal above the dentate line has 8–10 vertical mucosal ridges called the ‘anal columns (of Morgagni)’ (Figure 4). Between the lower ends of adjacent columns are a series of curved folds of mucosa called ‘anal valves’. Together, these anal valves form the dentate line.

Above each anal valve is a shallow mucosal pocket called the anal sinus. The ducts of mucus-secreting anal glands are located in the mucosa or submucosa, opening into each anal sinus. Infection of these anal glands is an important cause of perianal sepsis.

The epithelium above the dentate line is like the glandular epithelial lining of the rectal mucosa and is made up of columnar cells, crypts, and goblet cells. In contrast, the anal canal distal to the dentate line is lined with non-keratinized stratified squamous epithelium. Distally still, at the anal verge and just proximal to it, the anal canal is lined with sensitive, thick, hair-bearing skin.

Arterial supply and venous drainage of the anal canal

Arterial supply

The inferior rectal arteries supply the external and internal anal sphincters as well as the mucosa over the lower half of the anal canal.[1–3] However, the mucosa proximal to the dentate line is supplied by terminal twigs of the superior rectal artery. The middle rectal arteries do not contribute much to the arterial supply of the anal canal. There is a rich anastomosis between these arteries within the wall of the anal canal.

Venous drainage

The veins draining the anal canal mirror the main arteries that supply the anal canal and originate in the venous plexus situated in the anal wall. This plexus is continuous with the intramural rectal venous plexus. Venous channels from the upper part of the anal canal (proximal to the dentate line) drain mainly into the superior rectal vein and thereby eventually to the portal venous system. Venous drainage from the part of the anal canal distal to the dentate line is mainly to the internal iliac veins either directly

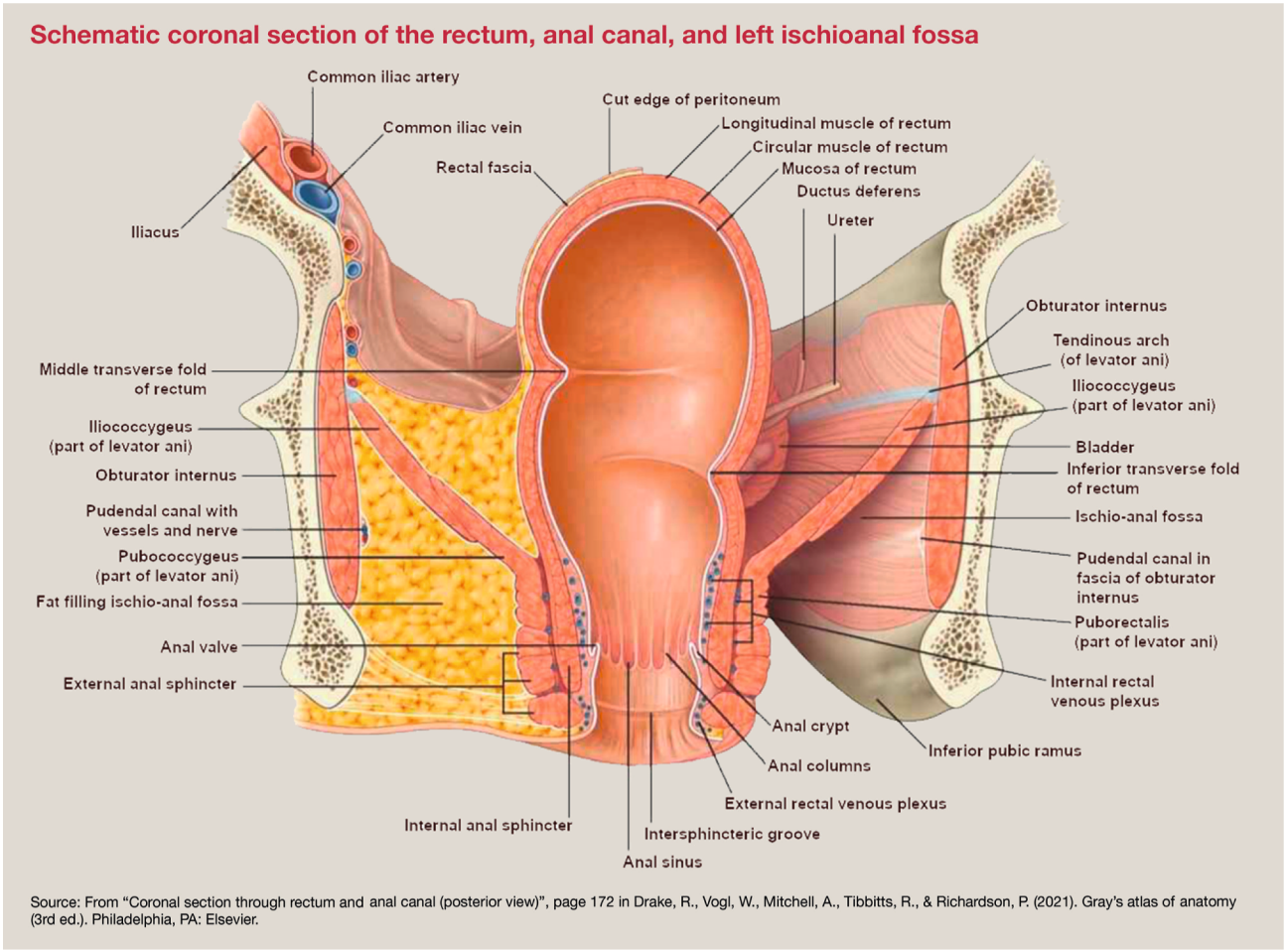


Figure 4

via the middle rectal veins or indirectly via the inferior rectal veins and internal pudendal veins.

Learning point

There is a portosystemic anastomosis in the anal canal in which venous blood from the anal canal proximal to the dentate line drains to the portal system while venous blood from the anal canal distal to the dentate line drains to internal iliac veins.

As has already been stated above, the upper half of the anal canal represents a site of natural portosystemic anastomosis. In addition to the intramural venous plexuses in the anal wall, and very possibly related to them, are arteriovenous mucosal cushions situated in the upper half of the anal canal. These cushions are thought to aid the internal and external anal sphincters in effecting tight closure of the anal canal.

The lymphatic drainage of the anal canal

The dentate line marks a watershed between two different lymph node destinations for lymph from the anal canal.[4] Lymph from the distal half of the anal canal, below the dentate line, drains bilaterally to the superficial inguinal lymph nodes. However, lymph from the anal canal proximal to the dentate line drains primarily to the internal iliac lymph nodes bilaterally, and less so to the pre-aortic, inferior mesenteric lymph nodes on the posterior abdominal wall.

Anal sphincters and continence

The internal anal sphincter, the external anal sphincter, the puborectalis sling, and the arteriovenous mucosal cushions are important for the production and maintenance of anal continence (Figure 5).

The internal anal sphincter is the distal extension of the inner circular muscle layer in the rectal wall. It is approximately 3–4 cm long and 4–5 mm in thickness in the adult. Its motor innervation is derived from the autonomic nervous system (predominantly sympathetic) as for other smooth muscle. The distal edge of the internal sphincter is well-demarcated and easy to palpate.

The internal anal sphincter contributes 60–75% of the resting anal tone while the external anal sphincter and puborectalis collectively contribute about 20%. The remainder is provided by the dilated anal mucosal cushions which have already been referred to above.

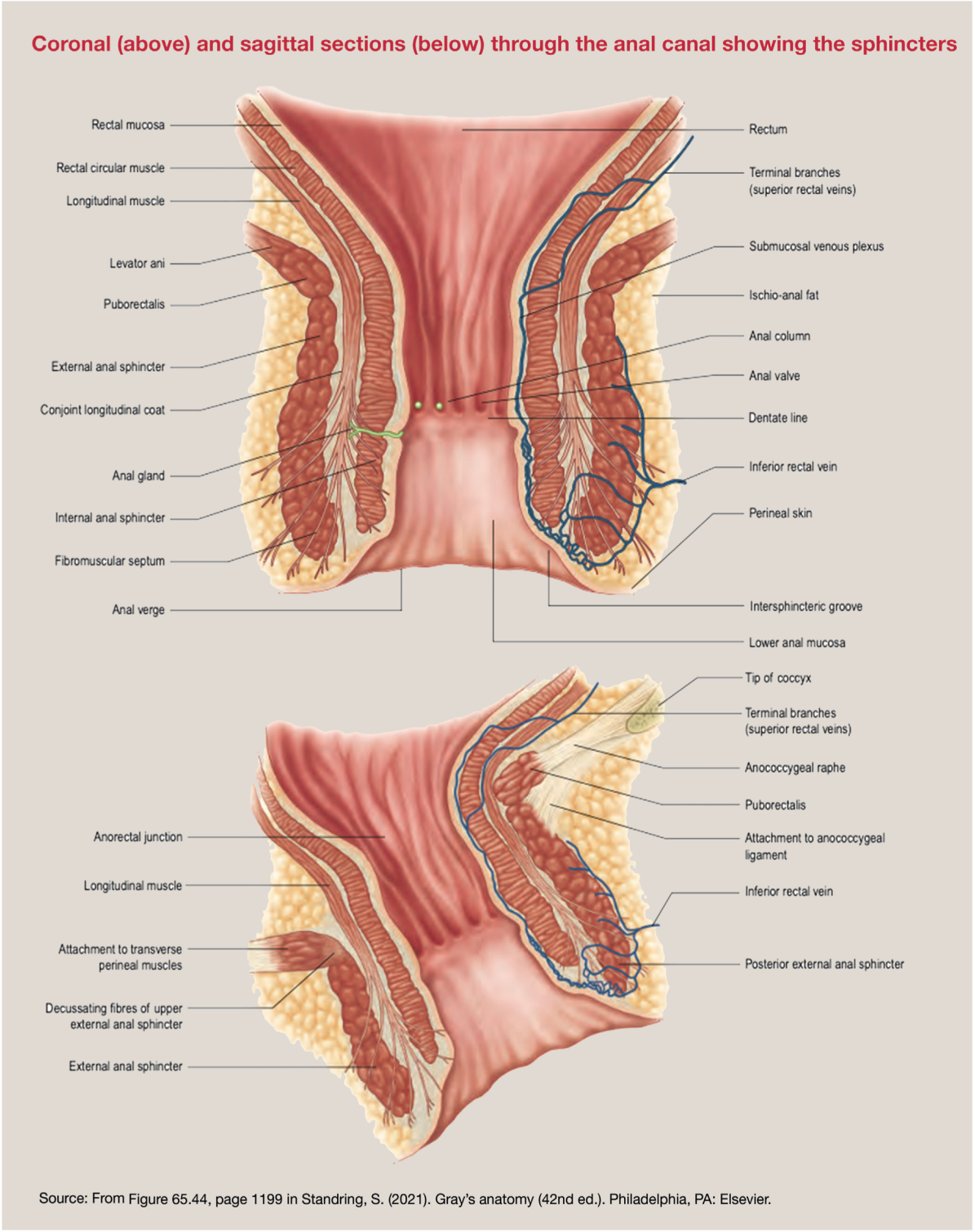


Figure 5

The external anal sphincter is conventionally described as consisting of three parts: a subcutaneous part, a superficial part, and a deep part.[1–3,5] However, neither during surgical procedures on the anal canal nor in meticulously performed cadaver dissections is it possible to demonstrate three discrete parts. What is clearly seen, however, is that the external sphincter is longer and wider than the internal sphincter, and that the distal edge of the external anal sphincter is normally distal to that of the internal sphincter by at least 1 cm. Between these two edges, it is relatively simple to palpate the intersphincteric groove.

The external anal sphincter is made up of striated (voluntary) muscle. Its innervation is, as expected, by somatic nerves — the

inferior rectal nerves, each derived directly from the corresponding pudendal nerve.

The puborectalis sling comprises those fibres of each levator ani muscle which arise from the periosteum of the posterior surface of the pubic bone lateral to the pubic symphysis. These fibres run posteriorly initially and then medially behind the anorectal junction to meet their counterparts from the other side. Together these fibres form a sling behind the anorectal junction (Figure 2). The constant tonic contraction in this sling accounts for the sharp anorectal angle.

Voluntary relaxation of the puborectalis sling allows straightening of the recto-anal tube – a prerequisite to defaecation.

The puborectalis muscle is innervated like the rest of levator ani by the ipsilateral perineal branch of the fourth sacral nerve (S4), a branch of the lumbosacral plexus. The deepest part of the external anal sphincter blends with the puborectalis sling behind the anorectal junction. This area of fusion is palpable on per rectal digital examination and is referred to as the anorectal ring in surgical terminology. ◆

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Practice points

- In performing a total mesorectal excision for rectal cancer, the mesorectum is carefully dissected along Heald's 'holy plane', an avascular and easy to dissect plane between the perirectal and pelvic fascias. This is done to preserve the autonomic pelvic plexuses and nerves
- It is important to preserve the rectourethralis (a muscular bundle between the anterior perineal flexure of the rectum and the membranous urethra) muscle as well as the cavernous nerve or veins passing through it during a mesorectal excision
- A total mesorectal excision is not always essential. Indeed, a close rectal dissection may be preferable in the surgical management of benign rectal disease