Surgical Treatment and Pathology: Normal Histology

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Anal Canal: Anatomical, Surgical and Pathological Definitions

There are a number of commonly used definitions of the extent of the anal canal. Perhaps the most widely accepted definition is that the anal canal starts at the pelvic floor and finishes at the anal opening [20]. Surgeons usually define the upper limit of the anal canal at the level of the levator ani muscle (at the anorectal angle) and the lower limit at the anal orifice [16]. The surgical anal canal varies from 3.0 to 5.3 cm in length and is on average slightly longer in the female [17]. Pathologists typically define the anal canal as the area lying between the upper and lower borders of the internal anal sphincter [10] whilst anatomists define the anal canal as lying between the dentate line and the anal verge [17]. The anal canal can also be defined histologically based on the types of specialised mucosa present in the anal region (anal transitional zone and anal squamous zone). The surgical and pathological definitions of the anal canal extend more proximally than the anatomical/histological definitions. This results in the surgical and pathological anal canals including a ring of colorectal mucosa at their upper borders [23] which is not present in the anatomical/histological anal canals. This variation in classification leads to some overlap and confusion in terminology particularly in respect to the nomenclature of pathology in the upper anus (e.g. rectal vs anal tonsil, lower rectum vs anal colorectal zone/anal cuff). For classification and staging of anal pathology, both the WHO [14] and TNM [25] systems use the surgical definition of the anal canal.

The anal canal lies in direct continuation with the rectum above and perianal skin below. Perhaps its most important landmark is the "dentate line" a line which runs circumferentially at approximately the midpoint of the anal canal along the base of the anal columns. These columns (Columns of Morgagni) are 6–10 vertical mucosal folds which extend from the middle into the upper aspect of the anal canal. The anal columns are connected at their bases by small semilunar valves behind which there are small pockets called anal sinuses (or anal crypts). The anal glands drain into these sinuses. Below the dentate line, the anal canal has a smooth lining and this area is referred to as the pecten.

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Basic Histological Structure of the Anus

The anus has a similar structure to the rest of the gastrointestinal tract being composed of mucosa, submucosa and a muscular wall. However, unlike other parts of the large bowel, the muscular wall

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has a component of striated (voluntary) muscle (external anal sphincter) in addition to the usual muscularis propria (internal anal sphincter). There is marked variation in the mucosal histology within the anus (see section "Histological zones of the anus" and Fig. 4.1). The submucosa of the upper anus is similar to the submucosa of the rectum being composed of loose connective tissue, but in addition it contains a rich venous plexus (see vascular supply). Below the dentate line in the pecten, there is more dense fibroblastic tissue which tethers the squamous epithelium to the superficial aspect of the internal sphincter. This is said to form a submucosal barrier which may be important in limiting the spread of carcinoma.

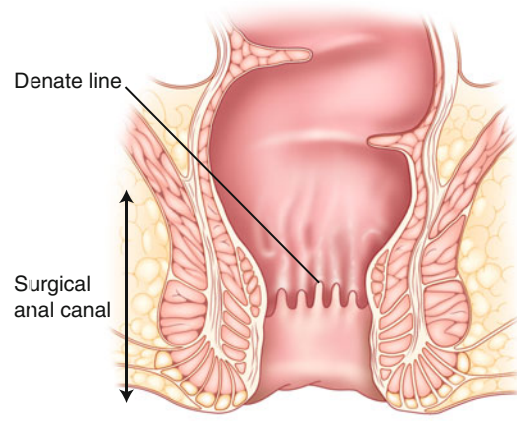

Fig. 4.1 Histological zones of the anal canal

Histological Zones of the Anus

The anal canal is divided into three separate histological zones according to the type of lining mucosa: the colorectal zone, the anal transitional zone and the squamous zone [9, 11]. These zones can be roughly mapped onto the anatomical landmarks of the anus, but there is some variation both between and within individuals [21].

The Colorectal Zone

The anal colorectal zone is lined by large intestinal-type mucosa and blends imperceptively with the lower rectal mucosa. The mucosa of the colorectal zone typically shows more crypt architectural distortion and shorter crypts than more proximal large intestinal mucosa with frequent branched/bifid crypts, and there are often mild mucosal prolapse-type features in this area (these include mild angulation of crypt outlines and mild fibromuscularisation of the lamina propria with vertically orientated bands of smooth muscle extending up between crypts). There are also changes in the type of mucin with goblet cells of the anorectum predominantly producing sialomucins rather than the sulphomucins found in the colorectum [6]. The colorectal zone starts at around the level of puborectalis and is typically 1–2 cm in length. Its mucosa merges with the mucosa of the anal transitional zone above, but close to, the dentate line.

The Transitional Zone

The anal transitional zone is lined by transitional-type mucosa and merges with the squamous zone below. There is an abrupt change from transitional- to colonic-type mucosa at the junction with the colorectal zone above. In some areas the transitional zone may be absent with large intestinal-type mucosa of the colorectal zone directly abutting squamous mucosa of the squamous zone. Other names for the transitional zone include the "intermediate zone" and the "cloacogenic zone". The anal transitional zone typically starts just above the dentate line, approximately 10 mm above the lower border of the internal sphincter, and is on average 5 mm in length, ranging between 3 and 11 mm [21]. The anal transition zone contains anal ducts which connect with the anal glands (see The Anal Blood Supply).

The anal transitional epithelium is normally 4–9 cell layers thick. The basal cells are small and perpendicularly arranged to the basement membrane. Cells at the surface of the anal transi-

tional mucosa can be columnar, cuboidal, flattened or polygonal. The columnar cells produce small volumes of mucin. Foci of squamous differentiation and occasional colonic-type glands may also be present. Endocrine cells are scattered in the transitional epithelium, and occasional melanocytes may be present [11] but Langerhan's cells are absent [12]. Similar to transitional epithelium in other regions, such as the bladder, anal transitional epithelium stains positively with CK 19 [24]. The transitional zone merges with the anal squamous zone below typically just above the level of the dentate line.

The Squamous Zone

The anal squamous zone (sometimes referred to as the "smooth" zone) anatomically corresponds to the pecten of the anal canal [10]. It is lined by non-keratinising squamous epithelium which merges at its lower border with perianal skin. The squamous zone lacks well-formed dermal papillae and skin appendages/adnexal structures. The squamous zone also lacks mucin-producing cells but melanocytes are present. As the epithelium approaches and merges with perianal skin, there is a gradual change in its cellular constituency with an increase in the number of melanocytes [4] and Langerhan's cells [12].

Mucosa-Associated Lymphoid Tissue of the Anus

There is mucosa-associated lymphoid tissue distributed throughout the large intestine but the amount varies markedly depending on the location. Lymphoid follicles are seen in the mucosa of the anal canal from the dentate line upwards [15].

In the anorectal region, the mucosa-associated lymphoid tissue can form a polypoidal structure which is known as a rectal tonsil [8]. This is more commonly seen in young children and adolescents. The aetiology of this is uncertain in most cases but the literature suggests that some of these cases may be linked to anorectal infections such as chlamydia [5]. Knowledge of this "normal" structure is important to avoid its misdiagnosis as lymphoproliferative disease.

The Anal Glands and Ducts

The anal glands drain via ducts which open into the anal transitional zone. Approximately 80 % of anal glands lie in the submucosa; however, the remainder of the anal glands are situated more deeply in the anal wall within the internal sphincter, the intersphincteric space and even the external sphincter [19]. Infection within anal glands is considered to be the main aetiological factor in the development of perianal fistulae [18].

The epithelial lining of anal glands is very similar to that of the anal transitional zone but a characteristic feature of the epithelium is the presence of intra-epithelial microcysts [11].

The Anal Musculature

The anal muscular wall is composed of the internal and external anal sphincters. The internal anal sphincter is a continuation of the muscularis propria of the rectum to which it has a similar structure although it is considerably thicker. The external anal sphincter is formed of striated muscle, is said to be composed of superficial and deep components and surrounds the internal sphincter.

The Anal Blood Supply

The anus has a rich arterial blood supply which is predominantly derived from the superior rectal artery (a direct continuation of the inferior mesenteric artery) but also receives contributions from the middle and inferior rectal arteries (branches of the internal iliac/pudendal arteries). In the upper anal canal, above the dentate line,

the anal submucosa contains a rich vascular plexus known as the anorectal vascular plexus which includes numerous arteriovenous connections. This is not evenly distributed throughout the upper anal canal but concentrated to form three anal cushions (left lateral, right anterior and right posterior) which have erectile tissue-type properties and are thought to be involved in the maintenance of continence. The anal cushions are also thought to be important in the pathogenesis of haemorrhoids [1, 22].

The Anal Nerve Supply

The inferior rectal nerves supply sensory innervation to the lower part of the anal canal. Free and organised nerve endings extend throughout the squamous zone and up into the transitional zone finishing just above the dentate line and providing sensation to touch, pain, hot and cold. However, above this the colorectal zone is devoid of such nerve endings and is dull to sensation [7, 11].

In the upper anal canal, as in the colorectum, the autonomic innervation is provided through submucosal and myenteric plexi which contain numerous ganglion cells. However, for the first centimetre above the dentate line (corresponding to the anal transitional and lower colorectal zones), ganglion cells are sparse or absent [2]. The density of interstitial cells of Cajal (the pacemaker cells of the colorectum) is also markedly reduced in the internal anal sphincter as compared to the rectum [13].

The Anal Lymphatic Supply

Injection studies have shown that an indirect or intramural system connects the lymphatics of the upper part of the anal canal to the lymphatic plexuses of the rectum and then onto the upper rectal nodes [3]. The lower part of anal canal below the dentate line and perianal skin is drained by the superficial inguinal nodes.

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