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THE ANATOMY OF THE RECTUM AND ANUS

BY

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THE ANATOMY OF THE RECTUM AND ANUS

"Doctors and medical students alike are frequently guilty of considerable laxity in their use of proctologic terminology. Perhaps they feel that careful differentiation of anorectal terms is of academic interest only. In reality, they would be amply repaid by a simpler conception of symptomatology, of diagnosis and of treatment of anorectal disease if they were willing to learn the fundamental principles of anatomy and of nervous physiology as applied to the anorectum."

So writes J. Peerman Nesselrod of Northwestern University Medical School at the beginning of Chapter XXVIII of Christopher, Textbook of Surgery[1], which is entitled "Anal Canal and Rectum."

To acquaint the writer with the anatomy of the so-called "anorectum" is the object of this paper.

Nothing will be said about the cecum, the ascending colon, the right colic flexure, the transverse colon, and the left colic flexure. The descending colon courses down over the anterior and lateral aspect of the left kidney and then passes over the left quadratus lumborum. Usually the descending colon is retroperitoneal, but according to Lesshaft[2], it may have a form of a mesocolon once in six individuals.

As the large intestine at this point passes over the crest of the left ilium, it becomes the sigmoid colon. The sigmoid is characterized by a mesocolon of varying lengths and it continues to the point over the middle of the third sacral vertebra where the large colon

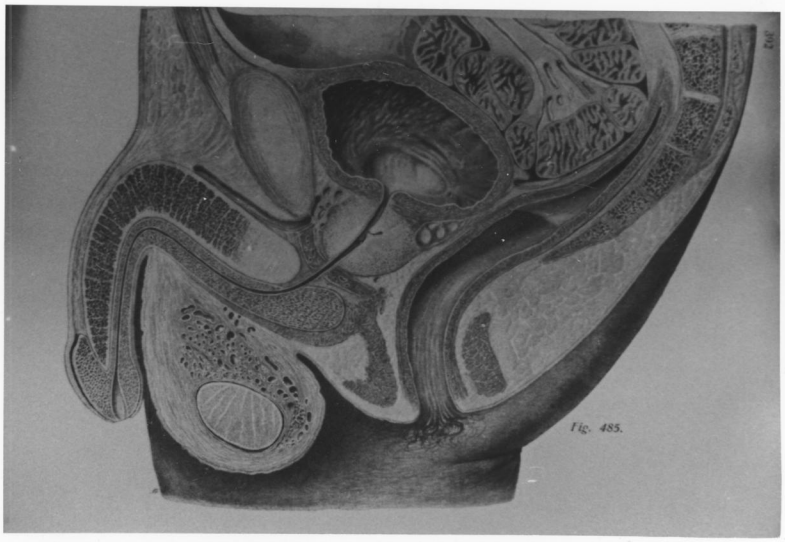


FIG. 1 - Saggital Section of the Male Pelvis Showing Relationship of the Rectum to the Other Organs.
(Sobotta)

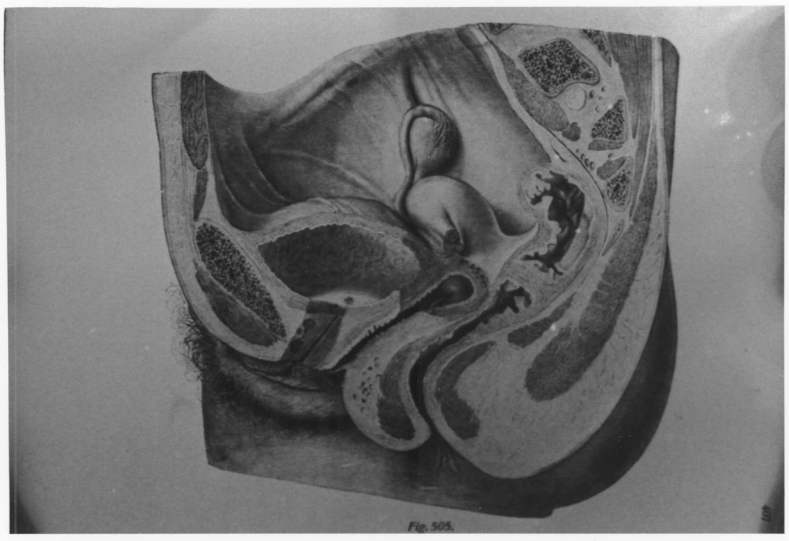


FIG. 2 - Saggital Section of the Female Pelvis
(Sobotta)

loses the term sigmoid and becomes the rectum. The sigmoid varies in length, but is usually 25 to 56 centimeters in length. After sweeping medially from its origin, the sigmoid colon may have no, but usually has several, free loops before it descends into the pelvis on the mid-line or just to the right of the mid-line of the sacrum.

The sigmoid colon becomes the rectum at the point over the middle of the third sacral vertebra. The rectum extends down in front of the sacrum and coccyx for about 12.5 centimeters to a point behind the lower part of the prostate in the male or to a point behind the lower part of the vagina in the female where the anal canal begins. Below the tip of the coccyx, the rectum rests on the superior fascia covering the levator ani muscle. The rectum is shaped into three dilatations, the lowest of which is the largest. The largest dilatation may measure 25 centimeters or more in circumference when distended and is called the ampulla of the rectum. These saccules are separated by semilunar foldings, the valves of the rectum.

The rectal valves (Plicae transversales recti) are semilunar folds extending two-thirds the distance about the lumen. They resemble transverse shelves when the rectum is distended as can be seen in Figure 3. They are relaxed and loose when the rectum is not distended. All the layers of the rectal wall except the longitudinal muscles are present in the valves which measure one to three centimeters from their free edge to their base. Often some of the longitudinal muscle fibres nearest the circular fibres are also incorporated into the structure. Three valves are usual, but four and five may be found. The most distal

rectal valve may be absent, but when present, it is about 2.5 centimeters above the anal canal. It extends usually from the left. Up 2.5 centimeters more, will be found the second fold which is the largest and which extends from the right side. The third extends from the left and is up another 2.5 centimeters. The study of frozen sections and rectal casts best demonstrates the relationship of the plicae transversales recti.

The rectal columns (Morgagni) are a series of permanent longitudinal mucosal folds. See Figure 3. They are one to two centimeters in length and may be five to ten in number. The columns are highest and broadest at the anal end of the rectum and deminish in all dimensions with ascension up the rectum. They are triangular in cross section and contain frequently longitudinal muscle, an artery and a vein. An enlargement commonly seen on the lower and larger end of the rectal columns is called the anal papilla.

The valves of Morgagni (anal semilunar valves) are small semilunar transverse folds of mucous membrane suspended between the lower and larger ends of the rectal columns and are located at the level of the uppermost border of the internal anal sphincter. They form pockets, the anal crypts, which have their openings facing upwards.

The rectal mucosa may be seen as a series of effaceable longitudinal folds often continuous with the rectal folds. The submucosal coat is very lax in the rectum, allowing great stretching. This is not the case in the anus.

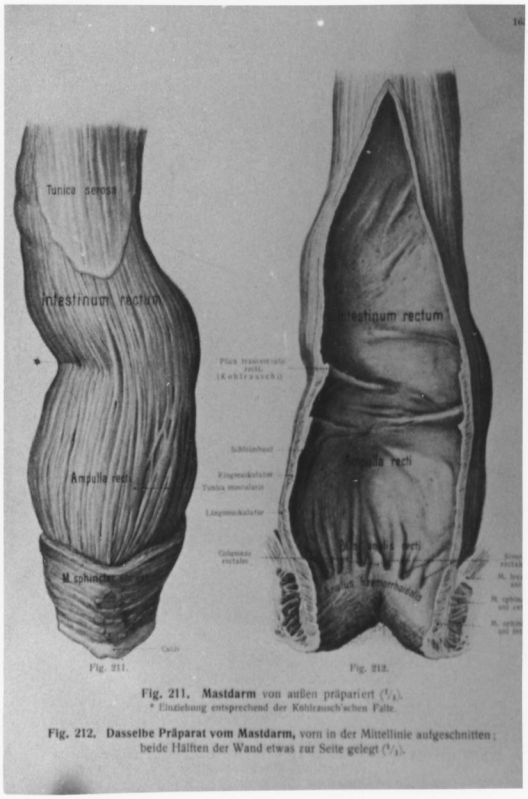


Fig. 211. Mastdarm von außen präpariert (1/1).
* Einziehung entsprechend der Kohlrausch'schen Falte.

Fig. 212. Dasselbe Präparat vom Mastdarm, vorn in der Mittellinie aufgeschnitten; beide Hälften der Wand etwas zur Seite gelegt (1/1).

FIG. 3 - The Anorectum

Left:- Shows the longitudinal musculature of the rectum and the musculature of the external sphincter.

Right:- The opened organ showing relationship of the rectal valves, the rectal columns, the ampulla, and the anal crypts.

An important difference between the rectum and the remainder of the large gut lies in the thickness and arrangement of the muscular coat. The longitudinal fibres are arranged into a continuous sheet completely surrounding the rectum. Again note Figure 3. The circular muscles are greater in thickness than in other parts of the colon and are usually two ore more millimeters. The circular fibres are internal to the longitudinal fibres as is the case in the rest of the gut.

The anal canal is located in the thickness of the pelvic floor. It extends downward and backward from its point of transition from the rectum. Its length is up to three centimeters. The anus is its terminal portion. The anal canal only has a lumen during the act of defication.

The internal sphincter is an extreme thickening of the distal portion of the circular muscle of the intestine. This muscle continues several centimeters down over the anal canal, is involuntary in its action and is about two times as thick as the rectal circular muscle. Thus, it is about four millimeters in thickness. Innervation is by the thoracolumbar sympathetics.

The sphincter ani externus is a very superficial muscle. It is composed of striated muscle fibres extending from the tip of the coccyx from the skin over the muscle itself and from the anococcygeal raphe posterior around the anal orifice to the central tendon where they meet anteriorly. In the female some of the fibres mingle with the fibres of the vaginal sphincter anteriorly. Innervation is via the fourth sacral

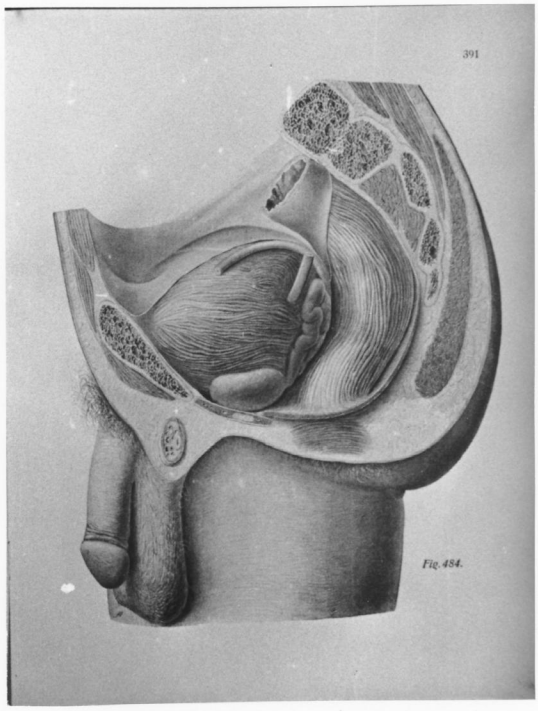


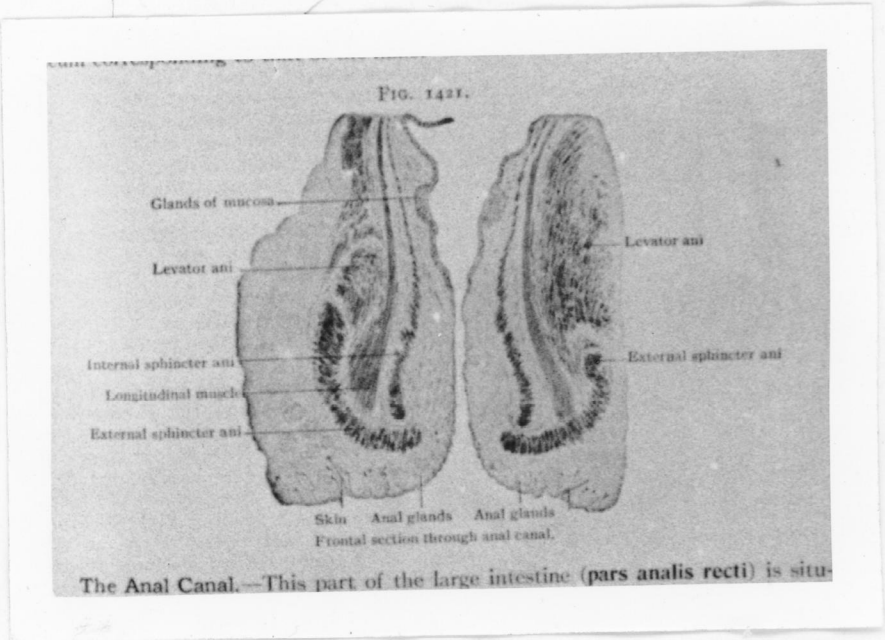
FIG. 4 - Near Saggital Section of Male Pelvis.

(Sobotta)

and inferior hemorrhoidal nerves.

There seems to be considerable intermingling of different types of muscle fibres in the anal region. Some of the unstriated fibres of the longitudinal muscle of the rectum mix with striated muscle of the levator ani as well as the external anal sphincter. Many of the above mentioned smooth muscle fibres terminate in the areolar tissue of the skin after they pass through the external sphincter. Others end in the loose connective tissue between the peritoneum and levator muscles. A group of muscle fibres connecting the skin about the anus with the submucous tissue (better called "subcutaneous" tissue) of the anus is the corrugator cutis ani.

Both the internal sphincter and the external sphincter involuntarily maintain a closed anus. The external sphincter has the added capacity of voluntary construction. Part of the time the levators probably aid the sphincters in their function, but when actively contracted, they cause the lifting of the pelvic diaphragm which is responsible for the dragging of the anus up and around the about-to-be evacuated feces. The feces cannot be forced up because of the greatly increased intra-abdominal pressure which results from the pulling in of the abdominal wall, the pushing up of the pelvic diaphragm and the pushing down of the thoracic diaphragm as in the straining of a stool with deep inspiration and a closed glottis.



The Anal Canal.—This part of the large intestine (**pars analis recti**) is situ-

FIG. 5 - The Anal Canal. (Piersol)

The Blood Supply of the Anorectum

Arterial Supply

The superior hemorrhoidal artery, the continuation of the inferior mesenteric artery, is the cardinal artery of the rectum. It lies at the root of the pelvic mesocolon where, at the level of the upper end of the rectum, it divides into two vessels which course down either side of the rectum itself giving off smaller branches to the rectal wall. These smaller branches pierce the muscular coat at about the middle of the rectum after which they course on down in the submucosa ending in the rectal columns and anal valves. In their descent they form, or unite with the hemorrhoidal plexus of the submucosa.

The middle hemorrhoidal arteries are two in number arising one on each side from the hypogastric artery itself or from the internal pudental artery. They supply the lower rectal musculature and anastamose with the hemorrhoidal plexus near the superior end of the anal canal. This artery also in part supplies the anterior aspect of the anal canal.

The inferior hemorrhoidal arteries are two or three or more in number on both sides and spring independently from the internal pudental arteries. They supply the levators and the sphincters as well as the anal canal. The branches supplying the anal canal are chiefly located posteriorly and anastamose with the hemorrhoidal plexus above.

Frequently the middle sacral artery sends some branches to the musculature of the posterior aspect of the rectum.

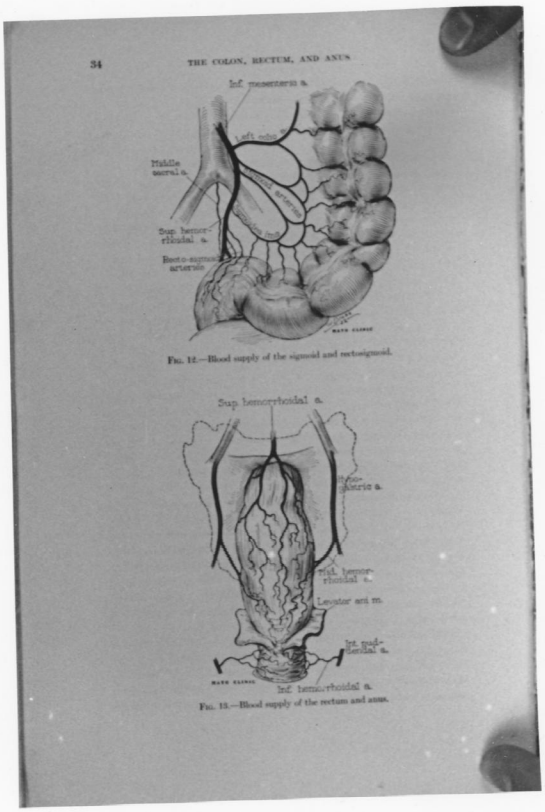


FIG. 6 - Arterial Blood Supply

Above:- Sigmoid and Rectosigmoid

Below:- The Rectum and Anus

(Rankin, Bargen, and Buie)

Venous Drainage

Two valveless venous plexuses are present about the rectum, the internal hemorrhoidal plexus and the external hemorrhoidal plexus. A group of radially disposed small veins (anal veins) are present just beneath the skin of the anus. Following upward, they join together and are joined by other veins of the region to form the larger vessels of the rectal columns which frequently are tortuous and may have pea-like dilatations at that point. These anastamose and cummunicate freely with one another to form the larger vessels which at about the mid-point of the rectum pierce the muscularis to form the superior hemorrhoidal vein. This is the internal hemorrhoidal plexus; it is within the muscularis.

The external hemorrhoidal plexus originates below by vessels that come from the above mentioned anal veins, but drain through the external sphincter to the plexus which lies on the outer surface of the rectum. The plexus is supplied also by veins that penetrate the rectal wall at intervals. Thus there is direct communication between the internal and external hemorrhoidal plexuses.

The superior hemorrhoidal vein leaves the plexus and unites with the left colic vein to form with it the inferior mesenteric vein. The inferior mesenteric vein drains into the splenic vein. Thus, the superior hemorrhoidal vein drains into the portal system. The middle hemorrhoidal vein on both sides joins the respective hypogastric vein directly and so drains into the inferior caval system as does the inferior hemorrhoidal veins which drain via the internal pudental veins to the hypogastric veins.

Batson[3] has recently shown through injection studies of the

dorsal vein of the penis of animals and the human cadaver the close relationship of the vertebral venous plexus with that of the venous plexuses of the pelvis. His demonstrations plus clinical observation show that the vertebral plexus can and does drain the pelvic plexuses. So is explained blood metastasis of malignancies from the region of the rectum and external genitalia to the vertebral column, thorax, and even the skull.

Lymphatics

The lymphatic drainage of the lower end of the anal canal is in part through the system that drains the perianal skin region to the inguinal and subinguinal lymph nodes. The remainder of the anal canal and the rectum are drained by one or two routs. One is through a lymphatic plexus in the mesocolon to nodes about the sacral promontory. The other is by lymph vessels and lymph nodes located on the wall of the rectum and they follow the superior hemorrhoidal vessels as well as the sacral and coccygeal lymphatic plexuses. The ultimate pathway thus is up the sacral, hypogastric and lumbar plexuses, important from the standpoint of lymphatic spread of malignant cells and infection.

Nerve Supply

Motor impulses to the circular muscles and inhibitor impulses to the longitudinal muscles of the rectum come from the sympathetic nerve supply which is derived from the superior hemorrhoidal nerve and plexus as well as the hypogastric plexus. The longitudinal muscles are stimulated and the circular muscles inhibited by the cerebro spinal nerves

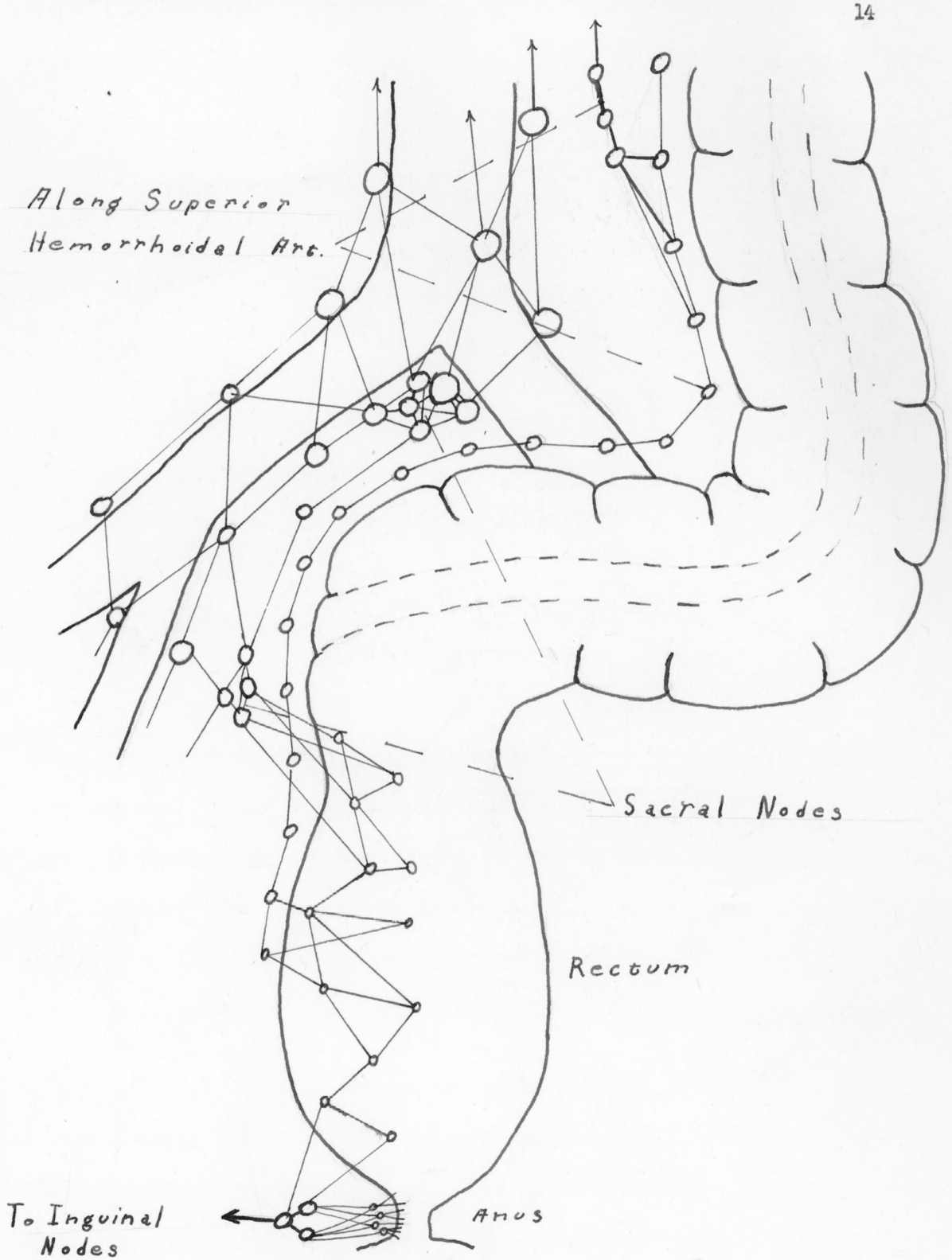


Fig 7.

Lymphatics of the Anorectum
and Pelvic Colon

(Sacral 2, 3, and 4) which come directly from the involved sacral foramina.

The defication center is located in the medulla and is capable of functioning without cortical control.

The Mucosa

The mucosa of the rectum is made up of cuboidal cells without celia. The glands, the so-called test tube glands seen in the whole colon are simple. Many goblet cells are present in these glands. This mucous membrane, like that of the upper portion of the intestine, is rather insensable to touch, pain, heat, etc., being supplied with visceral afferent innervation.

Actually the anal canal has no mucosa. It is lined with skin, stratified squamous epethelium which is often erroneously called anal mucosa. Being supplied with sensory somatic nerve fibres from the inferior hemorrhoidal branch (Sacral 3 & 4) from the pudental nerve and well supplied with them, it is particularly sensitive to touch and pain. The anus is derived from an invagination of ectoderm while the rectum is entodermal in origin. This explains many of its differences.

Confusion frequently results in the definition of the division point between anal canal and rectum. This is due partially to the multiplicity of nomenclature. The point of division between the anal canal and the rectum lies at the lower end of the rectal columns. This point of division is spoken of by many names, the most descriptive of which is the "dentate margin". The dentate margin is made up of the anal papillae, the valves of Morgagni (anal semilunar valves) and the anal

crypts. Other titles for the dentate margin are the pectinate line, the anorectal line and the mucocutaneous border. The white line of Hilton is a transverse line not always visible and only seen on the living. It is located about a centimeter distal to the mucocutaneous border and is formed by the functioning internal sphincter which lies just underneath the skin. It is sometimes called the intersphincteric line.

DEVELOPMENTAL ASPECTS AND ANOMALES

By the end of the fourth week of life the human embryo has a well developed archenteron (digestive cavity) with ectodermal invaginations of the embryonic plate at both ends which are separated from the cavity of the archenteron cephalad by the oroplate and caudad by the cloacal plate. Already the archenteron is divisible into three parts by its blood supply. These divisions will remain constant throughout life. The fore-gut is separated from the mid-gut by its liver bud and is supplied by the coeliac axis predominately. The mid-gut is supplied by the superior mesenteric artery; the hind-gut by the inferior mesenteric artery. These divisions of gut serve primarily as points for (1) digestion of food, (2) digestion and absorption, and (3) excretion, respectively. The hind-gut which in the mature individual originates just above the splenic flexure of the colon, terminates in the cloaca. From the cloaca spring the allantois, urinary bladder and urethra and secondarily the Wolffian ducts and ureters.

By the fifth week (Figure 8, A) the cloaca of the four millimeter embryo is relatively large and has springing from it the allantois with its dilated base, the anlage of the bladder. The Wolffian ducts also are present. The rectum is the last portion of the hind-gut before the cloaca, and the anus is the opening of the rectum into the cloaca. The cloacal membrane, made up of the invaginated ectoderm and adjacent wall of the cloaca is in tact. During the next week the anus and rectum move toward the cloacal membrane in such a manner that a septum results, which separates the rectum posterior from the

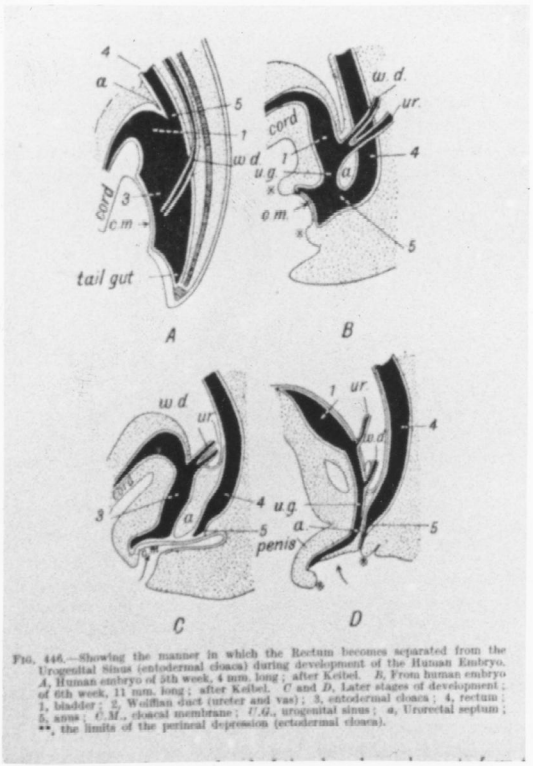


FIG. 8 - Early Embryology of the Rectum, Anus, and Lower Genitourinary System. (Keith)

bladder and urogenital sinus anterior. This septum is called the urorectal septum. The urogenital sinus is the open connection between what can now be called a cloaca and the bladder, Wolffian ducts and ureters. (Figure 8, B)

Due to the continued growth and downward movement of the rectum, the so-called cloacal anus, the anus mentioned above, makes contact with the cloacal membrane. (Figure 8, C) Now the rectum and anus are separated completely from the urogenital portion of the cloaca by the urorectal septum which has made contact necessarily with the cloacal membrane. The urogenital apparatus is to complete its development separated from the digestive system.

With these developments in mind, it is simple to understand how the rectum could empty into the urethra of the male on the vagina or vestibule of the female if the rectum did not descend to contact the cloacal membrane. The perineal body in the female is made up of the urorectal septum and the posterior aspect of the vestibular folds.

Perhaps the most common anomale of this region is the imperforate anus. This may be due merely to the failure to rupture of the thin cloacal membrane covering the cloacal anus. More serious is the case when the cloacal anus has remained closed and the rectum is perhaps an inch above the perineal depression and cloacal membrane and separated from it by tissue. Occasionally, due to the failure of the embryonic rectum to descend, there is no rectum at all, the lower end of the new born infant's sigmoid being a blind end. In the latter case the anus may be in tact, but also have a blind end. The anus and rectum both may

be absent.

Besides the above anomales occasionally there may be a congenital stricture of the anus and rectum or merely a congenital narrowing of the lumen.

Imperforate anus with a rectal fistula also occurs. The fistula may lead through the perineum, to the scrotum, the prepuce or the vulvovaginal orifice.

The rectum may open into the sacral canal due, according to Rankin, "to the persistance of the mesenteric canal with the opening of the postanal intestine in the sacral region."

It is generally considered that the anal valves and structures cephalad are entodermal in origin, those below being ectodermal, derived from the ectodermal invagination which meets the cloaca to form the cloacal plate.

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