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The surgical anatomy of the fasciae and the fascial spaces related to the rectum

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Summary: The perirectal fasciae and their vascular and neural relationships were studied based on the dissection of 46 fresh cadavers. The rectal fascia is a tubular sleeve, areolar in nature, which houses the superior rectal vessels and lymphatics. The nerves which supply fibres to the pelvic plexus run close to the rectum, contained in the urogenital and presacral fasciae. The rectum is attached to these two fasciae by the rectal stalks, which take a spiral course round the rectum, being posterolateral in the upper rectum, lateral in the mid-rectum and anterolateral in the lower rectum. During rectal resection the pelvic nn. may be preserved if the rectal dissection proceeds close to the rectal fascia. After cutting the rectal insertion of the presacral fascia, the lower rectal stalks (paraproctium) come into direct view and can be divided close to the rectal wall with no risk of damage to the pelvic plexus.

Anatomie chirurgicale des fascias et espaces en rapport avec le rectum

Résumé : Les fascias péri-rectaux et leurs rapports vasculo-nerveux ont été étudiés par dissection de 46 cadavres frais. Le fascia rectal est un manchon tubulaire, de nature aréolaire, qui enveloppe les vaisseaux rectaux supérieurs et les lymphatiques. Les nerfs qui alimentent le plexus pelvien courent près du rectum, contenus par les fascias uro-génital et pré-sacré. Le rectum est relié à ces deux fascias par les ailerons du rectum, dont le trajet en spirale est postéro-latéral à la partie haute du rectum, latéral à sa partie moyenne, antéro-latéral à sa partie inférieure. Au cours des résections rectales, il est possible de respecter les nerfs pelviens si la dissection du rectum est menée au ras du fascia rectal. Après avoir coupé l'insertion rectale du fascia présacré, les ailerons rectaux inférieurs (paraproctium) sont directement visibles et peuvent être sectionnés au ras de la paroi rectale sans risque de lésion du plexus pelvien.

Key words: Rectum – Anatomy – Fascia – Pelvis – Nerves

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It seems probable that there are few subjects in gross anatomy that have suffered so many diverse descriptions as the fasciae and fascia spaces around the rectum. One reason for many of the discrepancies in the various descriptions is the absence of a generally accepted definition as to how dense connective tissue must be before it can be regarded as forming a fascia [9]. There is also much individual variation in the gross anatomy of the extraperitoneal fascia, according to age, sex, nutritional status and constitutional factors. This paper presents a description of the surgical anatomy of the fasciae relating to the rectum and their neural and vascular relationship. There are also considerable differences in terminology among the three great Western schools of anatomy (English, French and German) and between anatomists and surgeons. These impede teaching, learning and the exchange of information. However, I have attempted here to harmonise the anatomic and surgical nomenclature.

Material and methods

The study of the pelvic fascia was based on the dissection of 46 fresh unembalmed cadavers, 24 female and 22 male, at the Pathology Department of the University Hospital, Cluj, Romania. The first 10 dissections (5 female and 5 male) served for familiarisation with the gross anatomy of the pelvic fascia and to elaborate the dissection technique. During the subsequent 30 dissections (16 female and 14 male) every connective tissue sheath was systematically followed, taking note of its general configuration, the density of the connective tissue, the changes induced by accumulation of fat and the fascial relation to the pelvic walls, viscera, vessels and nerves. The photographs used to illustrate the paper were taken during the last 6 dissections (3 female and 3 male).

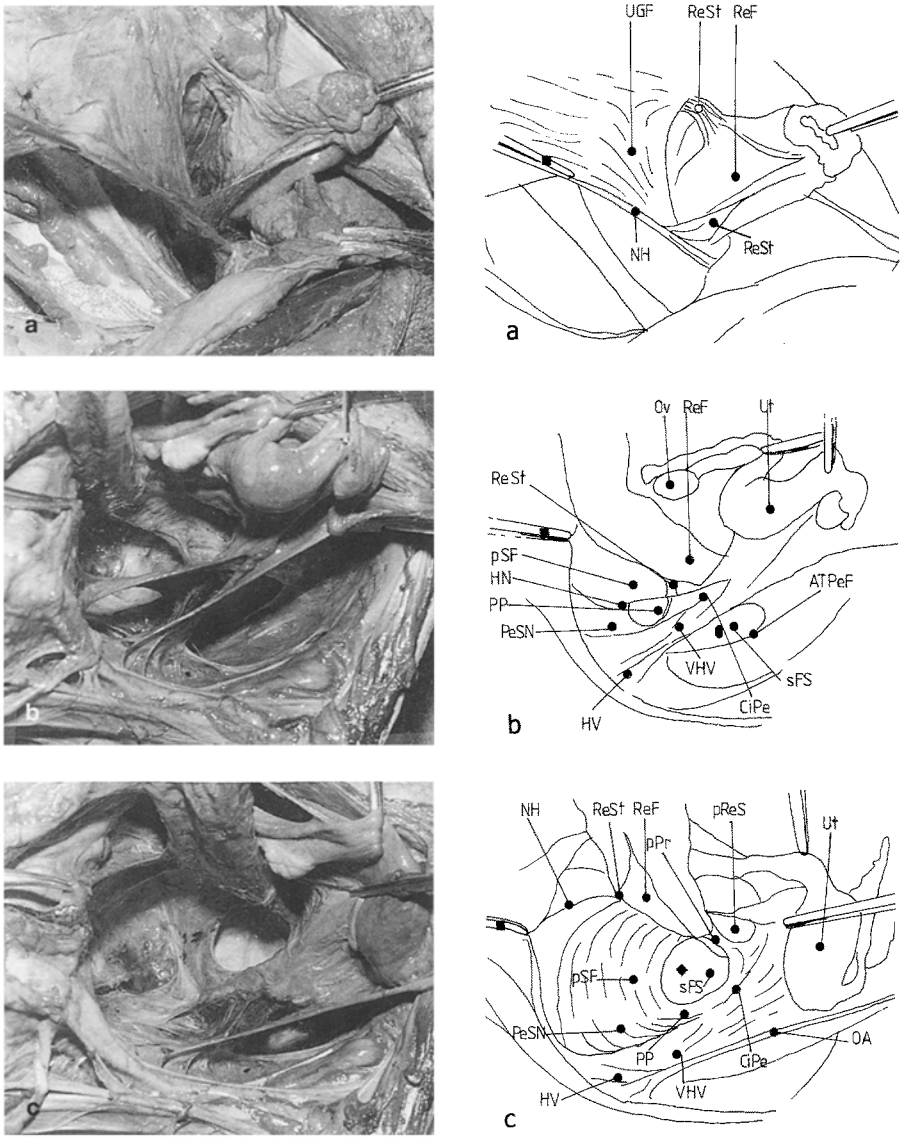

Fig. 1a-c. Dissection photographs of the perirectal fasciae in the upper rectum (**1a**), and lower rectum (**1b, c**).The insertion of the corpus intrapelvinum on the tendinous arch of the pelvic fascia was divided to visualise the subfascial space (**1b, c**). The presacral fascia was divided at its rectal insertion (**1c**)

Rectal dissection began with incision of the posterior parietal peritoneum on either side of the mesocolon and around the rectum. After developing the avascular plane behind the mesosigmoid, the sigmoid colon and its mesentery were divided on a line connecting the middle of the sigmoid loop to the origin of the superior rectal a. Next the presacral nn. (superior hypogastric plexus) were identified in front of the fifth lumbar vertebra, and a tape was placed round them. As the sigmoid was lifted forward, the slender sheaths of areolar connective tissue which connected the rectum to the presacral and hypogastric nn. are made evident (Fig. 1a). The rectal stalks were progressively divided and the dissection was taken deeper into the avascular plane between the fascia investing the rectum and that in front of the sacrum and coccyx (Fig. 1b). The anterior dissection of the rectum followed the plane between the fascia investing the rectum and the visceral fascia relating to the posterior aspect of the internal urogenital organs. The hypogastric nn., the pelvic splanchnic nn. and the pelvic (inferior hypogastric) plexus were successively identified and dissected. The rectal nn. and middle rectal vessels were then dissected in the lower third of the rectal stalks. Finally, the fasciae relating to the lower rectum were followed as far as the pelvic diaphragm.

List of abbreviations for all figures

ATPeF, tendinous arch of the pelvic fascia; *An,* anal sphincter; *C,* coccyx; *CIPe,* corpus intrapelvinum; *DD,* deferent duct; *HN,* hypogastric nn.; *HV,* hypogastric vessels; *LAM,* levator ani mm. invested by the pelvic parietal fascia; *OA,* umbilical a.; *OIM,* obturator internus m. invested by the pelvic parietal fascia; *Ov,* ovary; *OvV,* ovarian vessels; *P,* peritoneum; *paReS,* pararectal space; *PeSN,* pelvic splanchnic nn.; *PF,* parietal fascia; *PIM,* psoas and iliacus mm. invested by the pelvic parietal fascia; *PP,* pelvic plexus; *pPr,* paraproctium (lower rectal stalks); *Pr,* promontory and pelvic rim; *pReS,* prerectal space; *PrF,* prostatic fascia; *pSF,* presacral fascia; *pSF->Re,* rectal insertion of presacral fascia; *PSN,* presacral n.; *ReF,* rectum and its investing rectal fascia; *ReSt,* rectal stalks; *rReS,* retrorectal space; *ReVeS,* rectovesical septum; *sFS,* subfascial space; *Si,* sigmoid colon and mesocolon; *SP,* sacral plexus; *UW,* urogenital fascia; *Ur,* ureter; *Ut,* uterus; *UtA,* uterine a.; *VaF,* vagina and investing vaginal fascia; *VeF,* urinary bladder and investing vesical fascia; *VHV,* visceral branches of hypogastric vessels; ◆, presacral fascia was cut at its rectal insertion to visualise the subfascial space; ■, haemostat on the presacral n.; ●, the parietal insertion of the corpus intrapelvinum on the tendinous arch of the pelvic fascia was divided, to visualise the subfascial space.

Results

Rectal fascia (Figs. 1, 2, 3, 4)

Below the peritoneal level the fascia around the rectum formed a tubular sleeve, loose and areolar in nature, which houses the superior rectal vessels and the rectal lymphatics and nn. This fascia was a part of the pelvic visceral fascia, reflected upward on the rectum from the superior fascia of the pelvic diaphragm. Thicker close to the pelvic floor and in its anterior part, the rectal fascia became thinner as it ascended on the rectal wall. It was easily separable from the rectal musculature and contained a considerable amount of fat, larger on the dorsal aspect of the rectum, around the branches of the superior rectal vessels, where it resembled a bilobed lipoma (mesorectum). At the peritoneal level the rectal fascia became continuous with the subse-

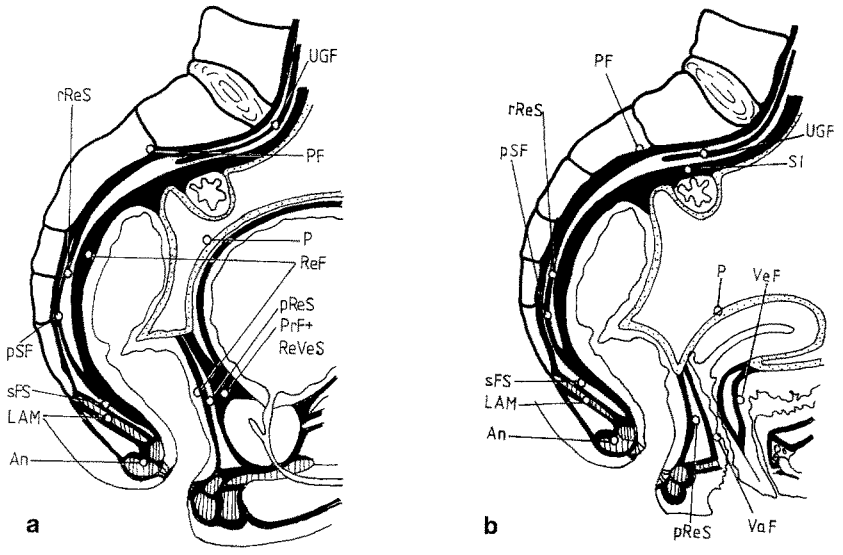

Fig. 2a, b. Perirectal fasciae and spaces in a median section through the pelvis in the male (**2a**) and female (**2b**). The dense black spaces represent the fasciae and the white areas inside them the vessels and the nn. which they house

rous layer (tela subserosa) of the peritoneum on the front and sides of the rectum. Dorsally, it was continuous with the mesentery of the sigmoid colon, without a clear boundary.

Perirectal fasciae

Surrounding the rectum and ensheathed by its fascia there were some connective tissue sheaths, varying in strength but always thicker than the flimsy rectal fascia, forming the so-called "gaine rectale" of the French anatomists [11, 22]. Behind the upper rectum there was the urogenital fascia, separating the rectum from the first two sacral vertebrae. In its lower part, the rectum was related posteriorly and laterally to the presacral fascia, stretched "like a hammock" [18] between the two tendinous arches of the pelvic fascia. The anterior rectum below the peritoneal level was related to the part of the visceral pelvic fascia associated with the internal urogenital organs. The rectum was attached to the surrounding fascia by paired rectal "ligaments" or "stalks".

Urogenital fascia (tela urogenitalis [21]; gaine urinaire [11]; intermediate stratum of the retroperitoneal tissue [15]) (Figs. 2, 3, 4).

This was a connective tissue sheath on the posterior abdominal wall, associated with the kidney, genital vessels, ureters and presacral nn. (superior hypogastric plexus). At the pelvic brim the urogenital fascia accompanied the ureters and the hypogastric nn. into the pelvis. It descended below the promontory for a few cm in front of the first (and rarely the second) sacral vertebra, where it ended in front of the presacral fascia, sometimes with a conspicuous border arched between the two hypogastric nn. On the pelvic wall, under the peritoneum of the pararectal fossae, the urogenital fascia invested the ureters (always lateral to the nerves) and, in males, the deferent ducts. As it descended on the pelvic wall, housing the hypogastric nn. on their way to the pelvic plexus, the urogenital fascia blended with the presacral fascia at the superior level of the sacrogenital ligg..

Presacral fascia (Waldeyer's fascia [9]; retrorectale Leitplatte [13]; fascia retro-rectal [19]; rectosacral fascia [20]) (Figs. 1, 2, 3, 4).

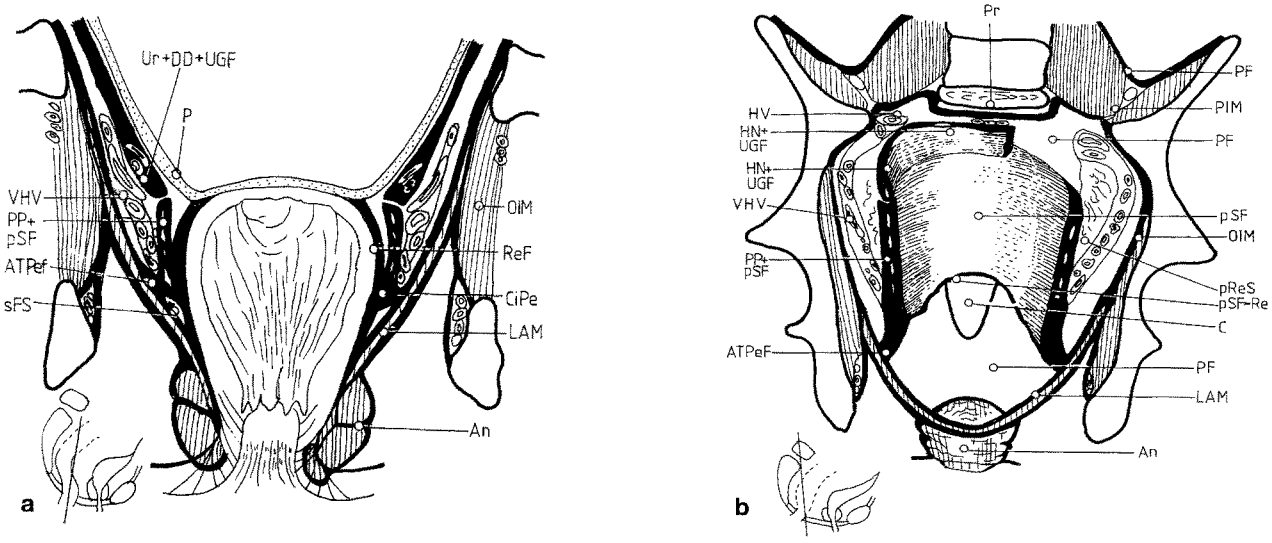

Fig. 3a, b. Perirectal fasciae and spaces in coronal sections through the pelvis at the rectal level (**3a**) and behind the rectum (**3b**). The dense black spaces represent the fasciae and the white areas inside them the vessels and the nerves which they house

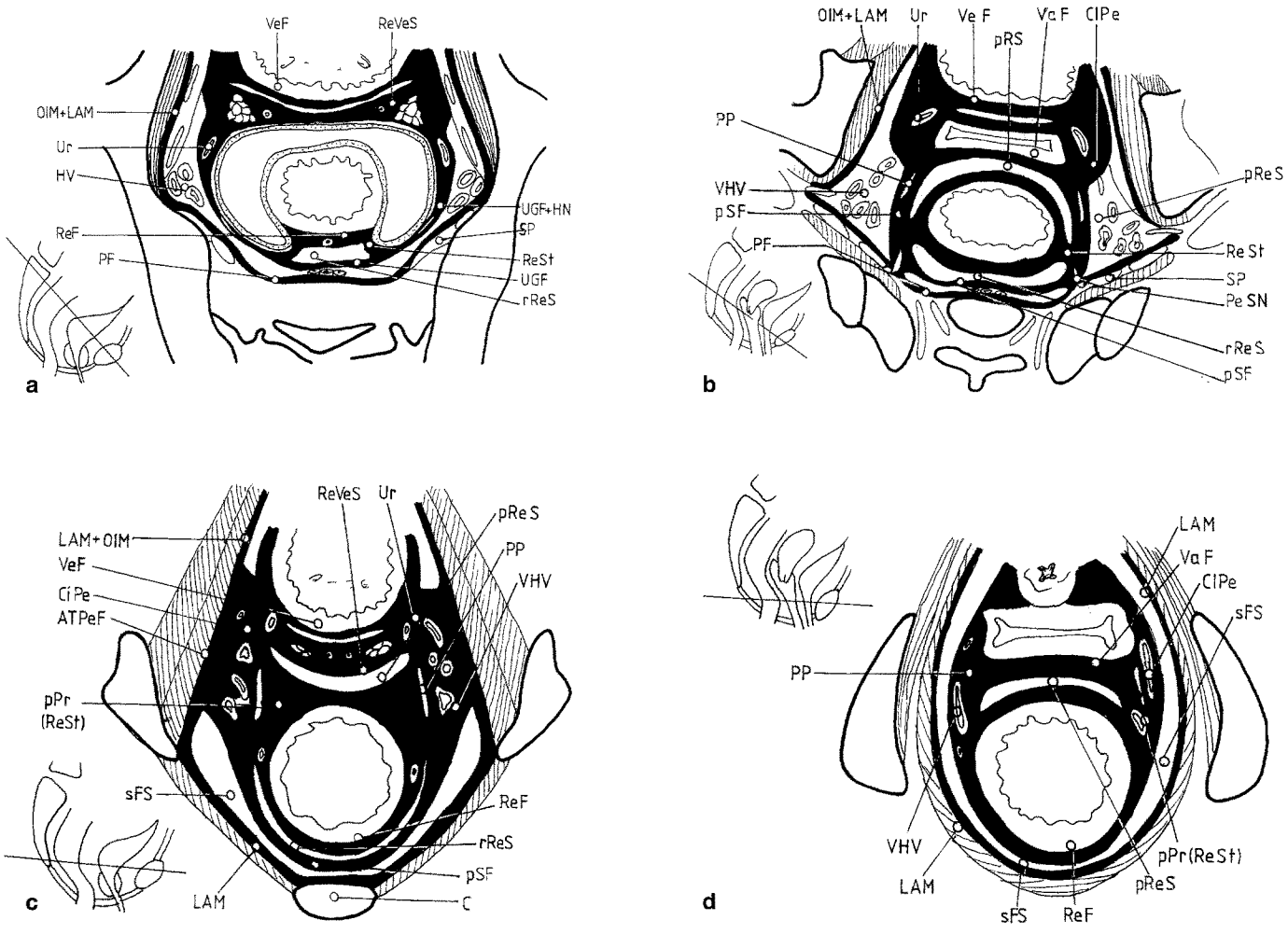

Fig. 4a-d. Perirectal fasciae and spaces in successive horizontal sections through the pelvis in the male (**4a, c**) and female (**4b, d**). The dense black spaces represent the fasciae and the white spaces inside them the vessels and the nerves which they house

This originated on the front of the second and third sacral vertebrae, forming a continuous hammock-like sheath, behind and lateral to the rectum [17, 18]. In the median plane, the presacral fascia descended in front of the sacrum, the medial sacral vessels, the coccyx and the anococcygeal. raphe, to the rectal fascia to which it was attached, 2 to 5 cm above the anorectal junction. At the level of the pelvic sacral foramina, the presacral fascia ensheathed the pelvic splanchnic nn. (nervi erigentes) and then, turning forwards in the paramedian (pararectal) plane, invested the pelvic plexus. In its lateral part, the presacral fascia was cranially continuous, at the upper border of the sacrogenital ligg., with the urogenital fascia and caudally it was attached to the rectum. Anteriorly, the presacral fascia blended with the corpus intrapelvinum [7, 16] (Becken Gefäss-Nerven-Leitplatte [13]; Bindegewebsgrundstock [12]) and the tendinous arch of the pelvic fascia (Figs. 1, 3, 4). The term corpus intrapelvinum names the paragenital mass of connective tissue associated with the visceral vessels and nn.

Rectal stalks (rectal ligaments or pillars [9]; ailerons rectaux [14, 22]; Rektumpfeilers [12]; lateral ligament of the rectum [20]) (Figs. 1, 3, 4). These connected the rectum to the perirectal neurovascular sheaths. At the rectosigmoid junction, the rectal stalk continued the mesosigmoid in the median plane and connected the bowel to the presacral nn. As the presacral nn. divided into the right and left hypogastric nn., which ran down into the pelvis, the rectal stalk divided into two sheaths connecting the nerves to the posterolateral wall of the upper rectum and the lateral wall of the mid-rectum. The left rectal stalk was usually thicker than the right because it housed the ascending parasympathetic nn. from the pelvic splanchnic nn., which ran up to the left colon [6]. The lower rectal stalks connected the pelvic plexus and the corpus intrapelvinum to the anterolateral rectal wall. The German anatomists have called this particular part of the rectal stalks the paraproctium [7, 16] (Rectaler Teil der Gefäss-Nerven-Leitplatte [13]; Rektumpfeilers [12]), posterior rectal division of the corpus intrapelvinum. The paraproctia were thick and housed the rectal nn. which arose from the pelvic plexus and the middle rectal vessels, when present. In 60 pelvic halves, the

middle rectal a. was found 46 times (76.7%). Of the 46 arteries, 21 (35%) were conspicuous and 25 (41.7%) were slender. The artery took a variable course in the paraproctium, sometimes close to the pelvic floor. The rectal stalks, as a whole, ran down round the rectum taking a divergent spiral course, being posterior at the rectosigmoid junction, posterolateral. at the upper rectum, lateral at the mid-rectum and anterolateral on the lower third of the rectum.

The subperitoneal rectum and its investing fascia were related anteriorly to the visceral fascia of the internal urogenital organs. (Figs. 2, 4) In the male, the posterior layer of the rectovesical septum continued the prostatic fascia upward to the peritoneum of the rectovesical pouch (the so-called prostatoperitoneal membrane; Denonvillier's fascia; anterior layer of Denonvillier's fascia). In the female, the vaginal fascia formed a tubular sleeve, easily separable from the fibromuscular vaginal wall, extending upward from the pelvic diaphragm fascia and investing the rich vaginal venous plexus.

Perirectal spaces (Figs. 1, 2, 3, 4)

Surrounding the subperitoneal rectum and its rectal fascia there was loose connective tissue which filled the space between the rectal and perirectal fasciae. The retrorectal space extended between the rectal and presacral fasciae. It was limited inferiorly by the fusion of the presacral and rectal fasciae and anteriorly by the rectal stalks. Between the rectal fascia and the visceral fascia of the internal urogenital organs was the prerectal space, bounded laterally by the corpus intrapelvinum and caudally by the superior fascia of the pelvic diaphragm. The subfascial space [7, 16] (supralevator space [5]), extended under the rectal insertion of the presacral fascia, round the posterior and lateral aspects of the rectum. It was bounded laterally and caudally by the superior fascia of the pelvic diaphragm. Lateral to the pelvic splanchnic nn. and the pelvic plexus, invested by the presacral fascia, there was another space of loose connective tissue, the pararectal space [22]. This space housed the hypogastric vessels and was bounded laterally by the parietal pelvic fascia which covered the piriformis m. and the sacral plexus.

Discussion

The pelvic fascia is continuous at the pelvic brim with the extraperitoneal abdominal fascia and expands below the peritoneal level to fill the spaces around the viscera. The pelvic fascia, whether associated with the walls of the pelvis (the parietal fascia) or the viscera (the visceral or endopelvic fascia) is a continuous layer and its subdivisions are thus somewhat artificial [9, 23]. In histologic sections the "fascia" and the "ligaments" of the subperitoneal tissue appear to be formed by loose connective tissue, in relation with strands of smooth muscle [31, nerves [1], and walls of blood-vessels, especially veins [21. Thus the term of "neurovascular sheaths" would be preferable [9], (Gefäss-Nerven-Leitplatte [13]; gaine hypogastrique [6, 14].To simplify description the term "fascia" was used even if such fasciae are not recognised in Nomina Anatomica or in modern anatomy text-books [23]. For practical purposes identification of the neurovascular sheaths of connective tissue is extremely important, making elegant and functional surgery of the pelvic viscera possible.

The rectal fascia, even if areolar in nature, is easy to recognise in thin persons. In obese patients it is more difficult to identify but always present as a clear boundary of the fat surrounding the rectal wall. The rectal fascia houses the blood vessels, the lymphatics and the rectal nn., forming the posterior lining and limit of the mesorectum. In its anterior part, which is related to the internal urogenital organs, the rectal fascia contains less fat and is more conspicuous. Naming this part of the rectal fascia "the posterior layer of Denonvillier's fascia" [8] generates confusion and in our opinion should be avoided. In this paper the connective tissue sheath which invests the genital vessels, ureters and presacral nn. at the pelvic brim has been called the urogenital fascia. Hollinshead [9] describes the presacral and hypogastric nn. as embedded in the presacral fascia. As already shown, even if the urogenital and presacral fasciae blend with each other at the superior border of the sacrogenital ligg., the two fasciae are distinct. In the median plane the urogenital fascia ends some cm below the promontory, whereas the presacral fascia originates from the front of the second and third sacral vertebrae and descends to the rectum, so that it has been called the suspensory lig. of the rectum [9].

The presacral fascia has been described [17, 18] as the neural connective tissue sheath which invests the pelvic splanchnic nn. (nervi erigentes) and the pelvic plexuses. External to the presacral fascia the pelvic parietal fascia is fused with the periosteum of the sacrum and coccyx and covers the piriformis m., the sacral plexus and the pelvic diaphragm. The presacral fascia originates from the pelvic parietal fascia in front of the second and third sacral vertebrae and from the pelvic sacral foramina, where it invests the pelvic splanchnic nn. at their origin from the sacral plexus. This is the posterior insertion of the "aponévrose sacro-recto-génito-pubienne" of French anatomists [10, 11, 22]. Lateral to pelvic sacral foramina, the presacral and pelvic parietal fasciae separate from each other, bounding the pararectal space which contains the inferior iliac vessels and their associated lymphatics.

At its lower border the presacral fascia is attached to the rectum and its fascia, separating the retrorectal and subfascial spaces. The presacral fascia must be cut at its rectal insertion during very low rectal resections and in abdominoperineal excision of the rectum, to isolate the last 2-3 cm of the rectum, the anorectal junction and the anal sphincter (Fig. 1b). The rectal attachment of the presacral fascia is sometimes mistaken for the rectal reflection line of the fascia covering the levator ani mm. (the superior sheath of the pelvic diaphragm). This reflection line is at the upper limit of the anal sphincter, 2-3 cm below the rectal insertion of the presacral fascia. At its lower and anterior border the presacral fascia binds to the corpus intrapelvinum and the tendinous arch of the pelvic fascia. At this point the lower part of the rectal stalks (the paraproctium) arise and run medially and dorsally to reach the anterolateral rectal wall, at 10 and 2

o'clock. The paraproctium houses the rectal nn. and the middle rectal vessels, when present. The nerves to the rectum arise from the pelvic plexus as a 1-cm long band, and reach the rectal wall 6-cm above the anus [18]. To preserve the pelvic autonomic nn. during very low rectal resections it is critical to divide the lower part of rectal stalks (paraproctium) just adjacent to the rectal wall and its investing fascia. The middle rectal a. has little practical importance in rectal surgery. In high rectal resections the paraproctium is preserved and thus the artery is not in danger. When the paraproctium is divided in low rectal resections, the middle rectal a., if present, is sometimes severed and the rectal stump relies on the sufficient arterial supply of the lower rectal vessels [9].

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