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The Anatomy of Lateral Ligament of the Rectum and Its Role in Total Mesorectal Excision

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Abstract

Background Lateral ligament of the rectum has suffered many diverse descriptions in its existence and composition. This study was undertaken to define the anatomy, nature, content of the lateral ligament of the rectum, and its role in total mesorectal excision.

Methods Cadaver dissections were performed on 32 formalin-preserved cadavers.

Results Bilateral lateral ligament appeared in all 32 cadavers as a bundle of dense connective tissue traversing between rectum and visceral fascia instead of pelvic sidewall. No substantial tissue strand except pelvic splanchnic nerves was found between visceral fascia and parietal fascia at the same level. The middle rectal artery was observed in only 18 of 64 pelvic-halves (28.1%). The constant component of the lateral ligament of the rectum was the rectal branches from the pelvic plexus, whereas the middle rectal artery was almost invisible in lateral ligament of the rectum.

Conclusions During total mesorectal excision, it is impossible to reveal the lateral ligament of the rectum in the correct plane between visceral and parietal fascia. The entire rectum may be mobilized without the need for ligating the middle rectal artery. The clinical significance of lateral ligament is that, during lateral dissection, if the dense lateral ligament was identified, then the surgical plane was medial to the visceral fascia and incorrect surgical plane thus entered.

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Introduction

The lateral ligaments of the rectum (LLR) have long been the subject of anatomical confusion and surgical misconception. Controversy focuses on two aspects: first, uncertainty of existence. Nowadays, lateral ligament has been regarded as a clinical or surgical term rather than an anatomical one [1–3]. From a surgical standpoint, Goligher describes LLR as "roughly triangular" structures with a base on the lateral pelvic wall and an apex "joining the side of the rectum" [4]. In contradiction to surgeons' acknowledgment of the lateral ligament, anatomists studying cadavers concluded they are merely a structure that is developed or sculpted during the process of dissection [5, 6]. Second, constitutions and components: the chief component of LLR is usually considered to be the middle rectal artery. However, Sato reported that the frequency of the middle rectal artery in LLR was only 22.2%, whereas nerves arising from pelvic plexus are found to be the constant component of LLR [7]. Rutegard excluded the classical hypothesis that the middle rectal artery is the core of the rectal lateral ligament and concluded that the ligament was comprised of nerves and other fibrous tissues [8].

From surgical standpoint, the clinical importance of LLR lies in two aspects: dissection of lymphatic spread of lower rectal cancer, and preservation of the autonomic nervous system in the pelvis [9, 10]. Therefore, tradition rectal surgery stressed the dissection of LLR during operation process. Goligher even described the detailed surgical procedures of clamping LLR between the middle and index finger of the left hand and then sharply severing it [4]. However, we have already noticed an interesting phenomenon: since the technique of total mesorectal excision (TME) has been advocated in rectal surgery, surgeons seem

to attach less importance to LLR. In 1982, Heald first described the technique of TME and did not mention the lateral ligaments; neither did he do so in a subsequent work published [11–13]. Many other surgeons in a description of mesorectal dissection made a brief mention or even did not refer to the lateral ligaments [14–16]. In fact, this conscious neglect reflected a better understanding of the anatomy of the pelvis. This study was undertaken to define the anatomy, nature, and content of the lateral ligament of the rectum and its role in TME.

Materials and methods

This study was based on the dissection of 32 formalin-preserved cadavers, 16 female and 16 male, at the anatomical department of the JiaoTong University School of Medicine in Shanghai. The study was approved by the local Ethics Committee. Detailed dissections were performed on 16 whole pelves and 32 hemi-pelves obtained by incising on sagittal plane along midline. Dissection was performed macroscopically but also with the assistance of binocular loupes (Heine, HR 2.5 × 340 mm).

The dissections were performed as follows:

1. *Dissection of LLR*: Rectal dissection began with incision of the peritoneum lateral to sigmoid colon and around the rectum. The sigmoid was lifted medially and forward to display the visceral pelvic fascia. Dissection was taken deeper into one avascular plane between perirectal fat and visceral fascia. A bundle of dense connective tissue with variable thickness can be clearly recognized at the level of ischial spine. Next, the connective tissue was incised along the pelvic portions of the psoas muscles. The dissection was followed plane anterior to the common iliac artery and progressively entering into another avascular plane between pelvic visceral fascia and pelvic parietal fascia.
2. *Anatomy of pararectal vessels*: The strong retraction and elevation of the rectum enabled the plane already developed posteriorly to be extended laterally and the space between the vesicohypogastric fascia and visceral fascia was entered. Gradually, structures, such as the umbilical artery, uterine artery, ureter, deep uterine vein, middle rectal artery, vaginal internal artery, and inferior gluteal artery, were isolated.
3. *Anatomy of pelvic plexus*: After removal part of the parietal fascia anterior to sacrum, sacral nerves S2-S4 were revealed. Splanchnic nerves from the third and fourth sacral root were dissected between visceral and parietal fascia. Pelvic plexus was identified at the junction of the hypogastric nerves and splanchnic nerves. The mentioned connective tissue strands between the rectum and visceral fascia were dissected to disclose the rectal branch arising from pelvic plexus.

Results

Anatomical location of LLR

Bilateral LLR appeared in all 32 cadavers. LLR was identified and characterized by a bundle of dense connective tissue with variable thickness traversing between rectum and visceral fascia at the level of ischial spine. No substantial tissue strand except pelvic splanchnic nerves was found between visceral fascia and parietal fascia at the same level (Fig. 1). The mean ± standard deviation (SD) of width and length of LLR was 1.70 ± 0.27 (range, 0.8–2.1) cm and 2.13 ± 0.32 (range, 1.2–2.5 cm) respectively. The distance from the midpoint of the band's visceral fascia attachment to the sacral promontory was 8.28 ± 0.26 (range, 7.4–8.6) cm on the right side, and 8.15 ± 0.22 (range, 7.2–8.3) cm on the left. The left and right distance from apex of coccyx to the band's visceral fascia attachment was 5.39 ± 0.40 (range, 4.8–6.2) cm and 5.19 ± 0.36 (range, 4.5–6.1) cm respectively.

Composition of LLR

Middle rectal artery

The middle rectal artery was observed in only 18 of 64 pelvic-halves (28.1%; Fig. 2). In 10 of 32 cadavers, a single middle rectal artery was found. Bilateral arteries

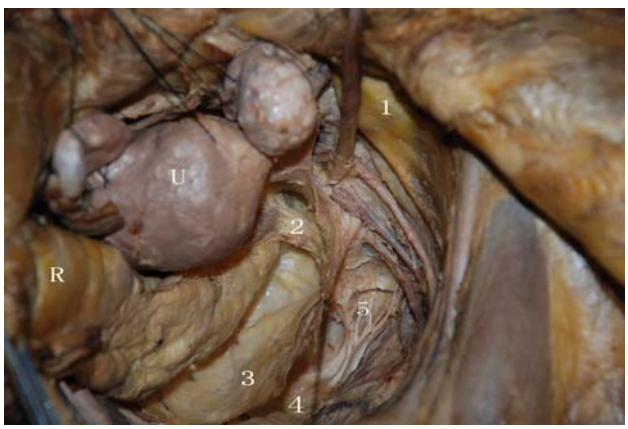

Fig. 1 The lateral ligament traverses between rectum and visceral fascia instead of pelvic sidewall. No substantial tissue strand except pelvic splanchnic nerves is found between visceral fascia and parietal fascia at the same level. *1*, vesicohypogastric fascia; *2*, lateral ligaments of the rectum; *3*, visceral fascia; *4*, parietal fascia; *5*, pelvic splanchnic nerve; *R*, rectum; *U*, uterine

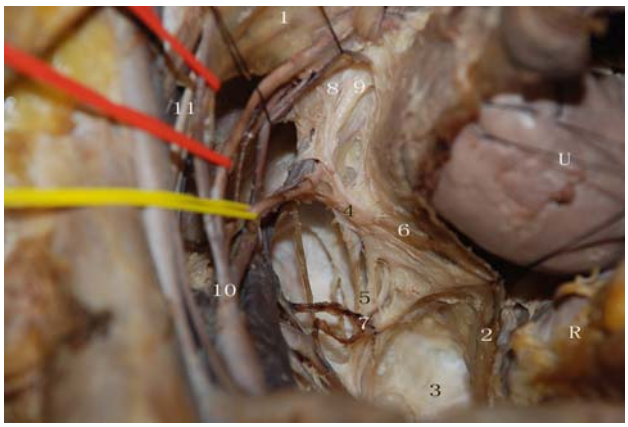

Fig. 2 The middle rectal vessels pass through the pelvic plexus and enter into the rectum. *1*, vesicohypogastric fascia; *2*, visceral fascia; *3*, parietal fascia; *4*, pelvic plexus; *5*, pelvic splanchnic nerve; *6*, hypogastric nerve; *7*, middle rectal vessels; *8*, bladder nerve branch; *9*, uterus nerve branch; *10*, internal iliac artery; *11*, obturator nerve; *R*, rectum; *U*, uterine

Fig. 3 The rectal branches arising from pelvic plexus constitutes the constant composition of lateral ligament. *1*, visceral fascia; *2*, pelvic splanchnic nerve; *3*, pelvic plexus; *4*, middle rectal vessels; *5*, rectal nerve braches (lateral ligaments of the rectum has been opened); *R*, rectum

appeared in only four cadavers. The most common point of origin is from the internal pudendal artery, occurring 12 times. Four arteries arise from inferior gluteal artery, whereas the other two originate from the internal iliac artery. The diameter of the artery at its origin was 1.27 ± 0.15 (range, 1–1.5) mm. The artery became gradually thin during the course to the visceral fascia and was almost invisible after penetrating through the visceral fascia.

Nervous constitutions

The pelvic splanchnic nerves arise from the anterior sacral roots S2-S4. These parasympathetic fibers converge with sympathetic fibers from the hypogastric nerve to form the pelvic plexus. The location of pelvic plexus is exactly external to the junction of visceral fascia and Denonvilliers' fascia. The rectal branches arising from pelvic plexus pass through visceral fascia and enter into rectum, which could be constantly found in LRR of all the 32 cadavers (Fig. 3).

Discussion

LLR suffered so many diverse descriptions since first referred by Miles in 1908 [17]. Surgeons have recognized LLR as an actual substance, which is a thick bundle of dense connective tissue between the lateral wall of the midrectum and the periphery of the internal iliac artery (or pelvic sidewall) [3, 18, 19]. However, there are few textbooks of anatomy that refer to an anatomical description of the lateral ligament in the pelvis. Jones believes that the "lateral ligaments" are artifacts produced by the obsolete process of blunt dissection during rectal mobilization. Therefore, he believes it is the important reason that Heald and others in describing the sharp dissection of total mesorectal excision do not mention these "ligaments" at all [20].

We report that the lateral ligament is an actual substance traversing between rectum and visceral fascia instead of periphery of the internal iliac artery or pelvic sidewall. No substantial tissue strand except pelvic splanchnic nerves was found between visceral fascia and parietal fascia at the same level. First of all, as the ligament, we believe that LLR must be obviously a bundle of dense connective tissue. The thin layer lateral to rectum described by Pak-art et al. [21] could not be the real "LLR"; rather, it is the lateral prolongation of Waldeyer fascia. Waldeyer fascia extends from posterior to lateral of the rectum, and the lateral prolongation of the fascia could be easily and incorrectly identified as LLR. Next, the anatomical location of LLR is between the rectum and visceral fascia. The surgical plane of TME has been proposed between visceral structures (rectum and mesorectum) and somatic structures (autonomic nerve plexuses, sympathetic above, and parasympathetic below) [22]. Therefore, it is impossible to reveal LLR performing TME with the correct surgical plane between visceral fascia and parietal fascia (Fig. 4). In addition, given the lumen of middle rectal artery was generally small (<1.5 mm) and often was absent (the incidence of 28.1%), the entire rectum may be mobilized without the need for clamping or ligating the middle rectal artery .We strongly believe this is the real reason why LLR is rarely referred after total mesorectal excision adapted in clinic. Since the surgical procedures were always performed in accordance with "layer," surgeons were likely to

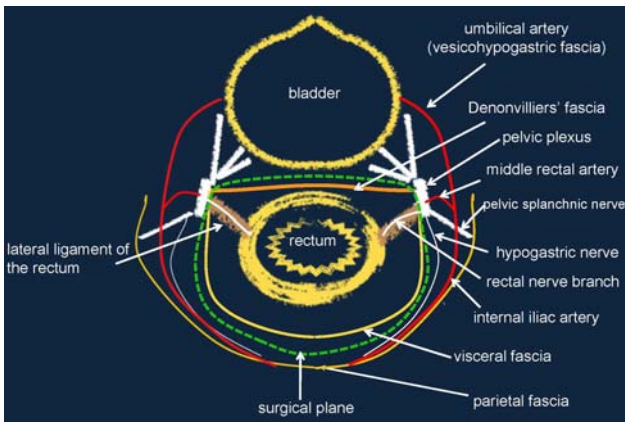

Fig. 4 Schematic drawing of the lateral ligament in total mesorectal excision: The rectum and mesorectum are enclosed by the visceral fascia. LLR was located traversing between rectum and visceral fascia. It is impossible to reveal LLR performing TME with the correct surgical plane between visceral fascia and parietal fascia. The green dotted line represents surgical plane

Fig. 5 The visceral fascia extends postolateral to the rectum, forming a continuous " hammock-like" sheath. *1*, parietal fascia; *2*, visceral fascia; *3*, Waldeyer fascia; *4*, Denonvilliers' fascia; *R*, rectum; *S*, seminal vesicles; *P*, prostate; *B*, bladder

find LLR compared with anatomists. This also may be the reason why LLR was called clinic term. The visceral fascia extends among the sacral concavity, Waldeyer fascia, and tendinous arches of the pelvic fascia in the ventro-dorsal direction, forming a continuous "hammock-like" sheath, behind and lateral to the rectum (Fig. 5). Consequently, visceral fascia is the real structure for the pelvic organ to fix and attach. A large amount of fat tissue filling between visceral fascia and pelvic wall embeds the pelvic viscera in a fatty, compressible layer that accommodates the pelvic organs contraction and pelvic pressure buffer. From this view, it is reasonable to regard LLR as the structure between visceral and parietal fascia.

From the point of previous study, the lateral ligament of the rectum was divided into lateral and medial portions, according to the positional relationship to the pelvic plexus [23]. According to our findings, the lateral ligament was just the previous so-called "medial segment," and the splanchnic nerves constitutes previous so-called "lateral segment." In total mesorectal excision, the medial segment may be excised, but the lateral segment must be preserved if urinary and sexual function is to remain intact. Undoubtedly, the traditional concept of clamping and dividing these ligaments will damage autonomic nerves. The clear definition of LLR is of great significance to TME surgery. The LLR can be distinguished as the landmark to judge the correct surgery plane. Simply speaking, during lateral dissection, if the dense lateral ligament was identified, then the surgical plane was medial to the visceral fascia, whereas no condense tissue instead of neurovascular bundles was visualized, the appropriate surgical plane was entered. If sharp dissection is performed easily without encountering any nerve structure, then either the plane between the rectum and visceral fascia was entered or the lateral visceral fascia adhered to the pelvic plexus was left behind.

In conclusion, LLR exists between rectum and visceral fascia within the mesorectum.

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