

Anatomy of the lateral ligaments of the rectum: A controversial point of view

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Abstract

The existence and composition of the lateral ligaments of the rectum (LLR) are still the subjects of anatomical confusion and surgical misconception up to now. Since Miles proposed abdominoperineal excision as radical surgery for rectal cancer, the identification by "hooking them on the finger" has been accepted by many surgeons with no doubt; clamping, dividing and ligating are considered to be essential procedures in mobilization of the rectum in many surgical textbooks. But in cadaveric studies, many anatomists could not find LLR described by the textbooks, and more and more surgeons also failed to find LLR during the proctectomy according to the principle of total mesorectal excision. The anatomy of LLR has diverse descriptions in literatures. According to our clinical observations, the traditional anatomical structures of LLR do exist; LLR are constant dense connective bundles which are located in either lateral side of the lower part of the rectum, run between rectal visceral fascia and pelvic parietal fascia above the levator ani, and covered by superior fascia of pelvic diaphragm. They are pathways of blood vessels and nerve fibers toward the rectum and lymphatic vessels from the lower rectum toward the iliac lymph nodes.

INTRODUCTION

Surgical approaches in the treatment of rectal cancer have undergone great changes over the past decades. Technical aspects have been studied and reviewed extensively in an attempt to reduce local recurrences and to decrease the incidence of urinary and sexual morbidity, but the existence and composition of the lateral ligaments of the rectum (LLR) are still the subjects of anatomical confusion and surgical misconception up to now^[1,2].

Since Miles proposed abdominoperineal excision (APR) as radical surgery for rectal cancer in 1908, APR has been rapidly accepted as a standard surgical strategy for rectal cancer^[3]. Since then, most colorectal surgeons accepted that LLR is the pathway of blood vessels and nerve fibers toward the rectum and lymphatic vessels from the lower rectum toward the iliac lymph nodes, and clamping, dividing and ligating LLR are standard and indispensable procedures during APR, which are described in classical surgical textbooks^[4-6].

Interestingly, based on cadaveric studies, many anatomists have intensively investigated the anatomy of LLR, but they could not find LLR described in the classical

surgical textbooks^[7-10]. In 1982, Heald *et al*^[11] demonstrated that total mesorectal excision (TME) alone could lead to a low rate of recurrence of rectal cancer in the pelvis and a high disease-free survival rate. But Heald and others described the sharp dissection of TME under direct view but did not mention LLR at all^[12-16]. This phenomenon seemingly testified many anatomists' findings based on cadaveric studies, but many surgeons still remain with confusion and misconception about the anatomy of LLR.

CLINICAL VIEWS ABOUT THE ANATOMY OF LLR

In the past decades, the surgical approach to the treatment of rectal cancer has been greatly refined, and from a gross, blunt, and blind dissection with flush clamping of lateral expansions, it has become a more accurate and less radical procedure. All of these improvements are related to a better understanding and a wider knowledge of the clinical anatomy of the pelvis^[17-24]. But there are different interpretations, and clinical studies about the anatomy of LLR still present quite diverse, and sometimes contradictory descriptions^[25-28]. The existence and composition of LLR are also issues with considerable controversies^[29-31].

In the history of radical surgery of rectal cancer, APR, proposed by Miles in 1908, was undoubtedly a breakthrough which greatly improved the outcomes of rectal cancer treatment^[32]. He had already referred to LLR while explaining his dissection procedure, stating that the dissection is carried downward on either side until the upper surface of the levator ani muscles is reached. LLR, which is recognized as a firm vertical band of fascia, requires dissection with scissors^[33]. He described that, LLR consists, on either side, of a broad band of dense connective tissues, which passes outward from the lateral walls of the rectum toward the base of the bladder at the point where the ureters terminate^[34]. Afterwards, APR was rapidly accepted as a standard surgical strategy for middle and lower rectal cancer.

Goligher *et al*^[35] also recognized LLR in a process of dissection around the rectum. LLR appears lateral to the mid-rectum after dissection on the anterior and posterior sides of the rectum is completed. He stressed that the lateral ligament can be clamped between the middle and index fingers of the left hand and then sharply severed. Based on Miles description and many surgeons' clinical experiences, LLR is considered to be a definitely existing anatomical structure, which is the pathway of blood vessels and nerve fibers toward the rectum and lymphatic vessels from the lower rectum toward the iliac lymph node, and clamping, dividing and ligating are required for LLR during APR. For a long time, there have been no controversies about LLR among surgeons.

The technique of TME advocated by Heald *et al*^[12] in 1982 is another breakthrough of radical surgery of rectal cancer, which could lead to an amazing low rate of recurrence of rectal cancer in the pelvis and a high disease-free survival rate. Since then, TME has become a basic principle in radical surgery of rectal cancer, and anterior

resection (AR) has gradually accepted to be a main surgical therapeutic strategy^[36-38]. But in their articles, they did not mention LLR at all, neither did they do so in the subsequent works. And no LLR was mentioned by many other surgeons in their descriptions of mesorectal dissection. With the principle of TME being accepted, LLR seems to be absent in proctectomy^[39,40]. Presently, LLR has become almost mythical structures, and met with considerable controversies among many colorectal surgeons about its existence and composition.

CONTROVERSIAL VIEWS OF LLR AMONG ANATOMISTS

With the development of radical surgery of rectal cancer, many anatomists have been engaged in the study of the anatomy of LLR. In contradiction to the classical knowledge of LLR, most anatomists studying cadavers did not find the typical structures of LLR described in traditional surgical textbooks. Their interpretations about the anatomy of LLR are quite different. The controversy focuses on three aspects: uncertainty of the existence, confusion of the composition, and unclear anatomic position in the pelvic cavity.

Jones *et al*^[41] noticed that, before TME principle was wildly applied in radical surgery of rectal cancer, identification of LLR is "hooking it on the finger" by surgeons during operation, and clamping, dividing and ligating are indispensable procedures described in surgical textbooks. In contrast, the mesorectum can be dissected by either diathermy or sharp dissection alone. In order to clarify the anatomic misconception about LLR, Jones *et al*^[41] studied the anatomy of LLR according to the TME principle for embalmed pelvis. In 1998, in their study of the anatomy of LLR, they concluded that, LLR does not exist; there is no anatomical argument against sharp dissection in the mesorectal plane and as a rule, there is no vessel that requires clamping; and by "hooking the finger" into the tissue literal to the rectum, it may be that the surgeon encounters mesorectal vessels and creates an artefactual ligament. This obviously raises the concern that such blunt dissection results in mesorectal tissue being left behind and increases the risk of local recurrence and severe autonomic nerve injury^[42,43].

Interestingly, by reviewing the relative literatures about LLR, and studying fresh cadavers and embalmed pelvis, Nano *et al*^[44] reported their interpretations of the anatomy of LLR in 2000, and drew the following conclusions: LLR is the extensions of the mesorectum and must be cut at their attachment at the endopelvic fascia; LLR contains fatty tissue in communication with the mesorectal fat and possibly some vessels and nerve filaments that are of little importance; LLR at the endopelvic fascia is inserted under the urogenital bundle; the middle rectal artery runs anteriorly and inferiorly in respect to LLR; LLR can be cut at their insertion on the endopelvic fascia without injuring the urogenital nervous bundle, which, however, should be kept visible during this procedure, because it crosses the middle rectal artery and runs out behind the seminal ves-

icles; the lateral aspect of the rectum receives the lateral pedicle, which consists of the nerve fibers and the middle rectal artery^[45].

In 2005, through studying the anatomy of human soft cadavers, Pak-art *et al*^[46] found that, in 36 hemipelvic specimens, 18 LLRs were found on the right side of the rectum and 18 were found on the left side. The location of LLR was posterolateral to the rectum. The content of LLR consisted of loose connective tissues with cluster of small nerves. No artery was detected in all specimens. The small arterioles and venules were discovered in only four specimens. They concluded that, LLR is located at posterolateral side of the rectum. Its component is loose connective tissues containing multiple small nerves.

Recently, based on dissections of 32 formalin-preserved cadavers, Lin *et al*^[47] found that LLR appeared in all 32 cadavers as a bundle of dense connective tissues traversing between rectum and visceral fascia instead of a 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. The constant component of LLR was the rectal branches from the pelvic plexus, whereas the middle rectal artery was almost invisible in LLR. They concluded that, during total mesorectal excision, it is impossible to reveal LLR in correct surgical plane. The entire rectum may be mobilized without the need for ligating the middle rectal artery. The clinical significance of LLR is that, during lateral dissection, if LLR is identified, the surgical plane is medial to the visceral fascia, thus the incorrect surgical plane appears.

Obviously, these diverse descriptions and interpretations of the anatomy of LLR by the anatomists inevitably convey confusion and misconception to clinical colorectal surgeons. Meanwhile, their studies undoubtedly contribute to reveal the true nature of the anatomy of LLR.

OUR PERSPECTIVE OF THE ANATOMY OF LLR

According to our clinical observations based on hundreds of cases of AR and APR per year, the anatomical structures of LLR described by Miles and Goligher *et al* do exist, which were repeatedly testified by colorectal surgeons who performed traditional APR^[48-51] (Figure 1). Because their descriptions of the anatomy of LLR were entirely based on clinical experience, and they had no idea about the concept of inter-fasciale at their time, during their blind and blunt surgical procedures, they failed to describe the precise anatomical position of LLR^[52]. In fact, the structures of LLR are entirely covered by endopelvic fascia according to the modern anatomical point of view^[53-57]. In other words, they are outside inter-fasciale, which is a correct surgical plane according to the TME principle. We believe that this is an important reason why LLR is rarely referred to after TME principle was adopted in radical surgery for rectal cancer.

Based on our surgical observation, we found that LLRs are connective bundles; their components include

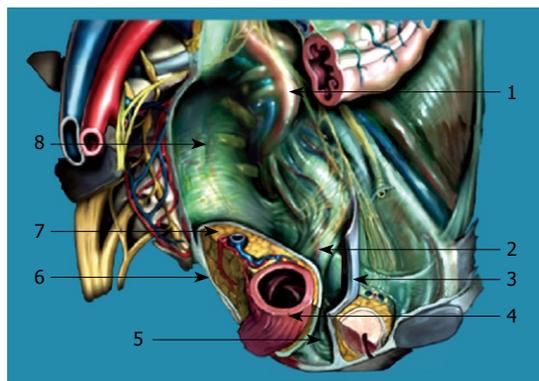


Figure 1 Illustration of the anatomy of the lateral ligament of the rectum. 1: Internal iliac artery; 2: Lateral ligament of the rectum; 3: Denonvilliers' fascia; 4: Distal part of the rectum; 5: Inter-fascial space around the distal rectum; 6: Waldeyer fascia; 7: Mesorectum; 8: Presacral fascia.

middle rectal arteries from internal iliac arteries, the rectal branches from the pelvic plexus, lymphatic vessels, some soft connective tissues and endopelvic fascia; they run between rectal visceral fascia and pelvic sidewall parietal fascia, covered by superior fascia of pelvic diaphragm above the levator ani, and terminate into the base of the distal part of the rectum laterally. Thus, LLR is a constant anatomical structure, which is the pathway of blood vessels and nerve fibers toward the rectum and lymphatic vessels from the lower rectum toward the iliac lymph nodes. The position of LLR is much lower than the surgeons thought to be. Presently, AR has been accepted as a main surgical therapeutic strategy for rectal cancer, LLR seldom needs to be treated during operation. We believe this is another important reason why LLR is rarely described by modern colorectal surgeons.

According to our clinical observations, the rectal visceral fascia extends along the pelvic cavity in the ventrodorsal direction, forming a continuous “hammock-like” sheath, enveloping the rectum^[58,59]. Inside the inter-fasciale between rectal visceral and pelvic parietal fascia, there is a continuous soft connective tissue layer which is a potential surgical plane containing no real ligation structures (Figure 2). These anatomical observations were testified by the study of Jones *et al*^[42]. And at the middle part of the rectum, LLR described by Nano *et al*^[44] is actually artifacts due to not strictly mobilizing the rectum along inter-fasciale between visceral and parietal fascia. But at the lower part of the rectum near the pelvic floor, either side of the rectum receives the lateral pedicle, which consists of nerve fibers and the middle rectal artery (Figure 3). In fact, what they called the lateral pedicle of the rectum is the real LLR described in classical surgical textbooks. Up to now, most anatomists do not acknowledge that LLR can be hooked by the finger of traditional colorectal surgeons. We believe that the real reason is that, LLR described in classical surgical textbooks is located away from where the anatomists are looking for. When they look for some structures without clear location, they may either see nothing, or mistakenly recognize other things as the structures they have already known.

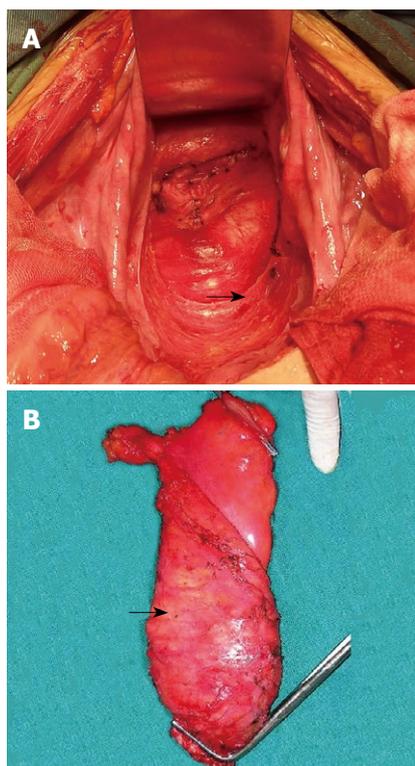


Figure 2 Operative photographs of open total mesorectal excision of rectal cancer. A: Under open surgery view, no ligament structures can be revealed in a correct surgical plane. Arrow indicates parietal pelvic fascia; B: Rectum has been removed completely. Arrow indicates rectum visceral fascia, and the rectum visceral fascia extends around the rectum, forming a continuous "hammock-like" sheath.



Figure 3 Operative photograph of laparoscopic total mesorectal excision of rectal cancer. 1: Left lateral ligament of the rectum; 2: Superior fascia of pelvic diaphragm; 3: Rectum visceral fascia; 4: Levator ani.

CONCLUSION

The existence and composition of LLR are still issues with considerable controversies up to now. Based on our surgical observations, we conclude that, LLRs are constant anatomical structures, which are pathways of blood vessels and nerve fibers toward the rectum and lymphatic vessels from the lower rectum toward the iliac lymph nodes; their components include middle rectal arteries, the rectal branches from the pelvic plexus, lymphatic vessels, some soft connective tissues and endopelvic fascia; their positions

are at lateral to either side of the lower part of the rectum; they run between rectal visceral fascia and pelvic parietal fascia, covered by superior fascia of pelvic diaphragm above the levator ani, and terminate into the base of the distal part of the rectum laterally. From these observations, we deduce that, during total mesorectal excision, it is difficult to reveal LLR in a correct surgical plane; the entire rectum may be mobilized between visceral and parietal fascia without the need for ligating LLR; and in the process of AR and APR, we should protect the integrity of rectal visceral fascia and pelvic parietal fascia to avoid the risk of local recurrence and severe autonomic nerve injury^[60-62].

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