



# Rectusial Fascia: A New Entity of Laparoscopic Live Surgical Anatomy



Maulana Mohammed Ansari\*

Department of Surgery, JN Medical College, Aligarh, India

Submission: April 07, 2017; Published: April 13, 2017

\*Corresponding author: Maulana Mohammed Ansari, Department of Surgery, JN Medical College, Aligarh, India. Residence: B-27, Silver Oak Avenue, Street No. 4, Dhaurra Mafi, Aligarh, UP, India, Mobile: 0091-9557449212; Email: [mmansari.amu@gmail.com](mailto:mmansari.amu@gmail.com)

## Abstract

**Introduction:** During laparoscopic total extra-peritoneal pre peritoneal (TEPP) hernioplasty for inguinal hernia, posterior epimysium of rectus abdominis muscle was studied, and the novel observations hitherto unreported in literature are presented herein.

**Materials and methods:** A prospective study was conducted in adult patients of inguinal hernia who underwent Laparoscopic Total Extra-Peritoneal Pre-Peritoneal hernioplasty under the ethical clearance and informed consent. Standard 3-midline port technique was utilized. Initial access dissection in posterior rectus canal was performed with unhurried to-and-fro movements of the 0° 10-mm telescopic for careful observation of undersurface of rectus abdominis.

**Results:** A total of 68 hernioplasties (Unilateral 52, and Bilateral 8) was performed in 60 adult male patients with primary inguinal hernia. Mean age and BMI were  $50.08 \pm 17.15$  years (Range 18-80 years) and  $22.58 \pm 2.03$  kg/m<sup>2</sup> (Range 19.5-31.2 Kg/m<sup>2</sup>) respectively. Epimysium on undersurface of rectus abdominis muscle was almost invariably found condensed and thickened in the form of a recognizable fascia under the excellent perspective and magnification of laparoscope, which was named as *Rectusial Fascia*. Rectusial fascia was found well-defined membranous/diaphanous in 88%, and it was thin/flimsy in 12%. Morphology of Rectusial fascia did not vary significantly with respect to age, BMI or occupation of individuals ( $p > 0.05$ ).

**Conclusion:** Rectusial fascia is a new entity of live surgical anatomy hitherto unreported in literature but, always appreciated by hernia surgeons during newer surgical approach of TEPP for laparoscopic inguinal hernioplasty. Usefulness of anatomic research in current laparoscopic era cannot be over emphasized because newer surgical approaches provide new vision of structures known for centuries.

**Keywords:** Rectusial fascia; Rectus abdominis muscle; Epimysium; Rectus abdominis fascia; Live surgical anatomy; Laparoscopic anatomy; TEPP anatomy; Inguino-abdominal anatomy; Hernia anatomy; Posterior rectus canal

## Introduction

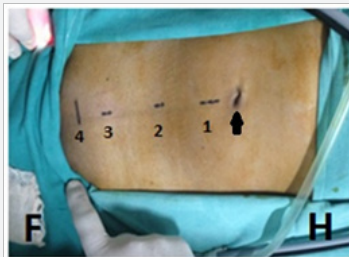
During training and teaching the procedure of the TEPP hernioplasty, it is always advised that the surgical plane should be created anterior to the posterior rectus sheath and all the same, the muscle fibers of the rectus abdominis should not be seen bare. If the muscle fibers of the rectus abdominis are seen bare in the operative field, the plane of dissection is said to be wrong. In other words, the operating laparoscopic hernia surgeon does recognize presence of a facial layer between the rectus abdominis muscle and the posterior rectus sheath regularly, and gives it a due importance with respect to the creation of the surgical plane, but he/she never bothers, nay dares, to name and describe it. This facial layer is really the posterior epimysium of the rectus abdominis muscle which has been disregarded up till now as an anatomic entity but which has recently assumed great surgical importance during the TEPP hernioplasty, and our observations are presented herein.

## Materials and Methods

A prospective doctoral research for award of PhD in Surgery was designed and undertaken in the Department of Surgery, J. N. Medical College, AMU, Aligarh, UP, India-202002 from April 2010 to November 2015. The study was conducted in the adult patients (*Homo sapiens*) of inguinal hernia who underwent the Laparoscopic Total Extra-Peritoneal Pre-Peritoneal hernioplasty (TEPP) under the ethical clearance of our Institutional Ethics Committee and written informed consent of the patients. Inclusion criteria were patients with age equal to or more than 18 years, patients with uncomplicated fully reducible primary inguinal hernia and patients with ASA grade I – II (American Society of Anesthesiologists). Exclusion criteria were patients with age less than 18 years, patients with severe co-morbid disease (ASA grade III – V), patients with recurrent inguinal hernia, patients with complicated inguinal hernia (irreducible/

inflamed/ obstructed/ strangulated), patients with femoral hernia, patients with history of lower abdominal surgery, and patient's refusal for laparoscopic repair.

The standard 3-midline port technique of the laparoscopic TEPP hernioplasty was followed as reported earlier by the author [1] was followed. Initial access dissection in the posterior rectus canal through the infra-umbilical 11-mm optical port was carefully performed with unhurried gentle to-and-fro movements of the 0° 10-mm telescopic for proper visualization and observation of the under surface (posterior epimysium) of the rectus abdominis muscle that forms the anterior boundary of the posterior rectus canal. This was followed by placement of two 5-mm working ports in the midline lower down (Figures 1 & 2) for the definitive dissection in the preperitoneal plane of the retropubic and inguinal regions for mesh placement. SPSS version 21 was used for statistical analysis.



**Figure 1:** Preoperative markings for port placement for laparoscopic total extra-peritoneal preperitoneal (TEPP) hernioplasty for right inguinal hernia. F: Foot end of patient; H: Head end of patient; Arrow: indicates umbilicus of the patient's abdomen; 1: infra-umbilical site for optical port (11-mm); 2 & 3: site for working ports (5-mm); 4: marking for upper border of pubic symphysis



**Figure 2:** port placement for laparoscopic total extra-peritoneal preperitoneal (TEPP) hernioplasty for right inguinal hernia. F, foot end of patient; H, head end of patient; T, optical port with 10-mm telescope in situ; 1, metallic optical port (11-mm); 2, 3, plastic working ports (5-mm)

## Results

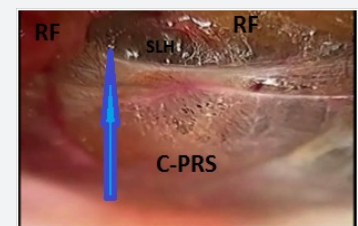
A total of 63 patients with the uncomplicated primary inguinal hernia were taken up for the TEPP hernioplasty. Three patients were excluded due to early conversion due to early peritoneal injury (1), early injury to deep inferior epigastric vessels (1), and early CO2 retention problem (1). Therefore, the present study included only 52 unilateral hernias (left side 35; right side 17) and 8 bilateral hernias, and hence, the data analysis was carried for a total of 68 hernioplasty performed

in the 60 patients. All patients were male (Groin hernia being uncommon in females, the three female patients with inguinal hernia presenting in the study period were not recruited for the laparoscopic hernia repair due to one or more exclusion criteria). Mean age of the patients (N=60) with inguinal hernia was  $50.08 \pm 17.15$  years (Range 18-80 years), and mean body mass index (BMI) was  $22.58 \pm 2.03$  kg/m<sup>2</sup>.

Upon entry into the posterior rectus canal and viewing with 0° 10-mm telescope (laparoscope) passed through the infra umbilical port, the canal was found always bounded anteriorly by a fascial structure covering the undersurface of the rectus abdominis muscle (and hence its fibers are not seen bare and the plane is said to be correct) and posteriorly by the posterior rectus sheath in the upper part and the transversalis fascia in the lower part if the posterior rectus sheath is incomplete. This fascial structure on the undersurface of the rectus abdominis muscle is hereafter called the '*Rectusial Fascia*' and abbreviated as the '*RF or R-Fascia*' for the sake of further reference and discussion.



**Figure 3:** Initial access dissection in posterior rectus canal. RF, rectusial fascia (well-defined and diaphanous) covering the rectus abdominis muscle on the roof; C-PRS, posterior rectus sheath (complete and tendinous) in the floor; Arrow, indicates the posterior rectus canal between RF and PRS

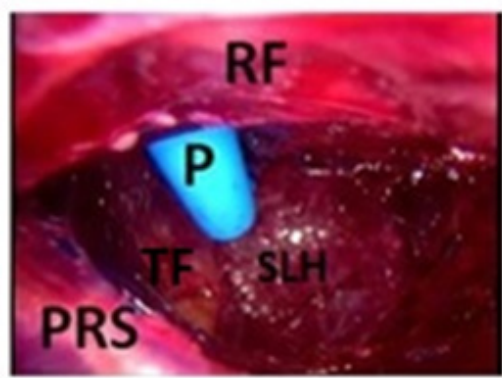


**Figure 4:** Initial access dissection in posterior rectus canal. RF, rectusial fascia (well-defined and diaphanous) covering the rectus abdominis muscle on the roof; C-PRS, posterior rectus sheath (complete and grossly attenuated) in the floor; Arrow, indicates the posterior rectus canal between RF and PRS; SLH, sign of lighthouse

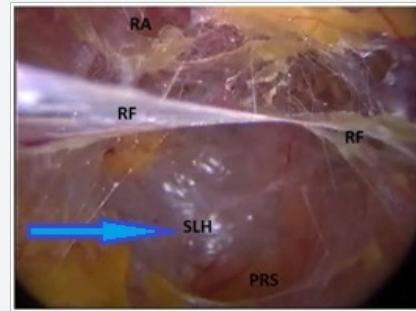
In the present study, this rectusial fascia was observed as a recognizable well-defined fascial structure in 60 out of 68 cases (88.24%) – thick diaphanous (Figure 3) & (Figure 4) in 47 cases (69.1%) and thick membranous (Figure 5) in 13 cases (19.1%); and it was thin in nature in 8 cases (11.76%) – thin membranous (Figure 6) & (Figure 7) in 3 cases (4.4%) and thin flimsy (Figure 8) & (Figure 9) in 5 cases (7.4%). In all cases, the deep inferior epi gastric vessels (DIEV) were found lying within this rectusial

fascia on the undersurface of the rectus abdominis muscle. In patients with incomplete posterior rectus sheath (PRS), the DIEV was present within the rectusial fascia above the arcuate line. In patients with the complete PRS [1], the DIEV appeared to course within the rectusial fascia running upwards from just above the symphysis pubis.

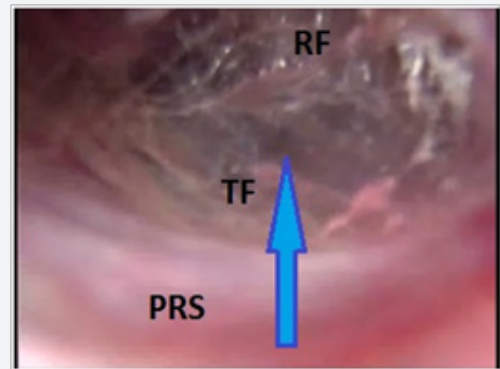
There was no significant de ( $p > 0.05$ ) between the mean age and BMI of the patients between the two groups (WD and FL) of the R-Fascia. Similarly, there was no significant correlation between the 2 subtypes of R-Fascia and the nature of patients' work in the present study (Pearson Chi-Square Correlation,  $R = 6.071$ ,  $df 5$ ,  $Sig. 0.299$ ,  $p > 0.05$ ) (Figure 10). In patients with the bilateral hernia ( $N=8$ ), the anatomy of the rectusial fascia was mirror image on the two sides of the body all cases (WD vs. WD in 7; FL vs. FL in 1) (Table 1).



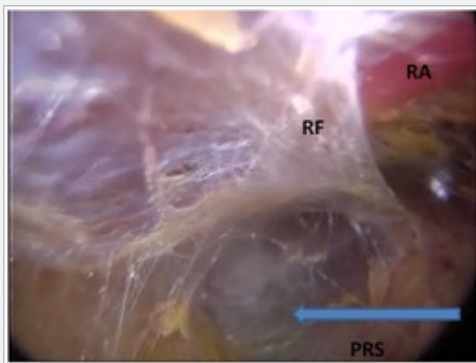
**Figure 5:** Initial access dissection in posterior rectus canal. RF, rectusial fascia (well-defined and thick membranous) covering the rectus abdominis muscle on the roof; PRS, posterior rectus sheath (incomplete and tendinous) in the floor; TF, transversalis fascia visible inferior to lower border (arcuate line) of incomplete posterior rectus sheath; Arrow, indicates the posterior rectus canal between RF and PRS; SLH, sign of lighthouse; P, 5-mm port/trocar (blue plastic)



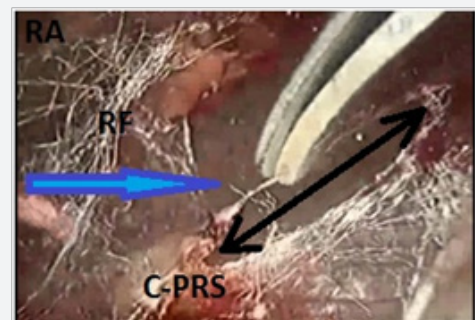
**Figure 7:** Initial access dissection in posterior rectus canal. RF, rectusial fascia (Thin membranous) covering the rectus abdominis muscle on the roof; PRS, posterior rectus sheath (incomplete and tendinous) in the floor; TF, transversalis fascia visible inferior to lower border (arcuate line) of incomplete posterior rectus sheath; Arrow, indicates the posterior rectus canal between RF and PRS; SLH, sign of lighthouse



**Figure 8:** Initial access dissection in posterior rectus canal. RF, rectusial fascia (Thin flimsy) covering the rectus abdominis muscle on the roof; PRS, posterior rectus sheath (incomplete and tendinous) in the floor; TF, transversalis fascia visible inferior to lower border (arcuate line) of incomplete posterior rectus sheath; Arrow, indicates the posterior rectus canal between RF and PRS; SLH, sign of lighthouse; P, 5-mm port/trocar (blue plastic)



**Figure 6:** Initial access dissection in posterior rectus canal. RF, rectusial fascia (Thin membranous) covering the rectus abdominis muscle on the roof; PRS, posterior rectus sheath (incomplete and tendinous) in the floor; TF, transversalis fascia visible inferior to lower border (arcuate line) of incomplete posterior rectus sheath; Arrow, indicates the posterior rectus canal between RF and PRS; SLH, sign of lighthouse



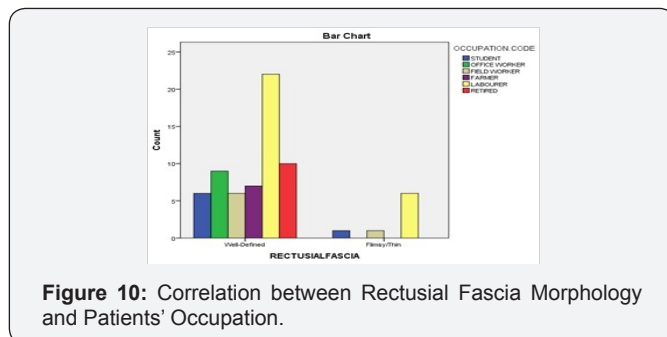
**Figure 9:** Initial access dissection in posterior rectus canal. RA, rectus abdominis muscle faintly visible; RF, rectusial fascia (Thin flimsy) covering the rectus abdominis muscle on the roof; C-PRS, posterior rectus sheath (Complete and membranous) in the floor; Black arrow (double headed), indicates surgically created artificial arcuate line in the complete membranous posterior rectus sheath for deeper dissection; Blue arrow, indicates posterior rectus canal between RF & C-PRS



**Table 1:** Bilateral Anatomy of Rectus Fascia in 8 Consecutive Patients who underwent Bilateral TEPP Hernioplasty.

S. No.	R-Fascia Type	
	Right Side	Left Side
1.	WD	WD
2.	WD	WD
3.	WD	WD
4.	WD	WD
5.	WD	WD
6.	WD	WD
7.	WD	WD
8.	FL	FL

R-Fascia: rectus fascia; WD: well-defined; FL: thin/flimsy



## Discussion

It is ironic that during laparoscopic learning and training for TEPP, if the fibers of the rectus muscle are seen bare, the plane of dissection is said to be wrong, and the operating hernia surgeon is always advised to remain under a facial structure covering the undersurface of the rectus abdominis muscle, i.e., the laparoscopic hernia surgeons always consciously recognize this facial structure during the TEPP hernioplasty, but no study is reported in the surgical or anatomical literature on this now-important fascia, which is herein termed as the *Rectus Fascia* by the author for further reference and discussion.

Rectus abdominis is a paired muscle of the anterior abdominal wall running vertically from the costal margins to the pelvic bones, one on each side of the linea alba in the anterior midline. Superiorly, rectus abdominis usually arises from the 5<sup>th</sup> to 7<sup>th</sup> costal cartilages, and often from the anterior part of the 5<sup>th</sup> rib also [2,3]. Medial border of the rectus abuts and often fused with the Linea Alba. Inferiorly, rectus abdominis is inserted through two tendons. Smaller medial tendon decussates with the opposite one and inserts on the anterior surface of the symphysis pubis. Larger lateral tendon is inserted on the pubic crest and sometimes on the pectineal line also. Lateral border is usually visible on abdominal surface as a groove, running from the tip of the 9<sup>th</sup> costal cartilage to the pubic tubercle, which is called the linea semilunaris [2,3].

The two rectus muscles are in contact with each other above the pubic symphysis because inferiorly, the Linea Alba is very narrow and posterior rectus sheath is typically absent. The anterior rectus sheath is firmly attached to the rectus abdominis while the posterior rectus sheath is not [2-4]. Usually the muscle has three tendinous intersections: one at the xiphisternum, one at the umbilicus, and one between these two. However, one or two incomplete intersections are sometimes present below the umbilicus. The tendinous intersections blend inseparably with the anterior rectus sheath [5]. These intersections contain multiple perforators from the epi gastric vessels, which supply the overlying anterior rectus sheath, fascia and soft tissue [6]. The perforators are most dense in peri umbilical areas. As the intersections lie superficially in the muscle and do not penetrate to its posterior surface, the rectus is not adherent/ attached to the posterior rectus sheath, and therefore, it is possible to insert the telescope easily into this retro-muscular space, often called the posterior rectus canal, during the laparoscopic total extra peritoneal pre-peritoneal (TEPP) hernioplasty.

Deep inferior epigastric and superior epigastric vessels are the main vascular supply of the rectus [2,3]. It also receives small terminal branches of the lower 3 posterior inter costal arteries, sub costal artery, lumbar arteries and the deep circumflex artery, which anastomose with lateral branches of the epi gastric arteries. The deep inferior epigastric artery arises from the external iliac artery at the level of inguinal ligament and passes upwards and medially. It then slips over the arcuate line and runs within the variably thickened epimysium (Rectus fascia) on the undersurface of the rectus abdominis muscle. The veins, usually two, accompany the artery and drain into the external iliac vein.

The epimysium is a fascia that covers the surface of a muscle, and depending on the muscle, it can be thin band or thick opaque [7]. The connective tissue fibres of the epimysium vary from areolar to thick bands of fibrous tissue [8]. Epimysium is thicker than the other elements (peri- and endomysium) of the intramuscular tissue, and it is formed by large-diameter collagen fibers [9]. Near the origin and insertion of the muscle, the epimysium thickens before it merges with the tendons and converges in the paratenon, while in the area of the muscle belly; it forms a thin layer [10,11]. During pre-peritoneal laparoscopy, the epimysium of the rectus abdominis is clearly seen in a similar fashion of variable proportions, and it usually forms a recognizable fascia, and the operating hernia surgeon is always advised to remain under this fascia during TEP approach, because if the fibres of the rectus muscle are seen, the plane of dissection is said to be incorrect. In the present laparoscopic study of live surgical anatomy, a clearly recognizable substantial Rectus fascia was documented in all 68 cases of the TEPP hernioplasties performed successfully, and its nature varied from well-defined membranous/diaphanous (88%) to thin/flimsy (12%). The Rectus fascia anatomy did not vary with respect to the age, weight/BMI or occupation of the patients.

In view of the facts that the groin hernia is of the commonest operations in general surgery and that the groin hernia occurs in both sexes albeit rarely in females, the present study has two limitations, viz., firstly, the sample size is rather small, and absence of female patients in the our study.

## Conclusion

Rectus fascia is a new entity of live surgical anatomy hitherto unreported in literature, but always appreciated by the hernia surgeons during the newer surgical approach of TEPP for laparoscopic inguinal hernioplasty. Morphology of the rectus fascia varied from thick well-defined to thin flimsy independent of the age, BMI and occupation of the individuals. Presence of the Rectus fascia observed regularly during the pre-peritoneal laparoscopy strongly supports the observation and recommendation of Avisse et al [12] that the newer surgical approaches provide 'new vision of structures known for centuries' and 'so, anatomic research is still useful'.

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DOI: [10.19080/OAJS.2017.03.555618](https://doi.org/10.19080/OAJS.2017.03.555618)

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