Intertransversalis Fascia Approach in Urologic Laparoscopic Operations

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Objectives: To study the clinical anatomy of the transversalis fascia (TF) and to explore the intertransversalis fascia approach in urologic laparoscopic operations (ULOs).

Design: Prospective study.

Setting: Two academic hospitals.

Other Participants: Data from 1217 urologic laparoscopic or open operations and 10 laparoscopic hernia repairs were analyzed between January 1, 2009, and April 30, 2011. Findings from 3 fresh autopsies were also included.

Main Outcome Measures: The anatomy of the TF was studied and the intertransversalis fascia approach was explored in ULOs; furthermore, they were proved in the open operations and fresh autopsies. Photographs were taken from the intertransversalis fascia approach in ULOs, micrographs were obtained to examine the microscopic structure of the TF, and the color atlas of TF anatomy (cross and sagittal sections) was drawn.

Results: The TF is a general plane of connective tissue lying between the inner surface of the transversus abdominis and the extraperitoneal fat. It can be divided into 2 layers (superficial and deep), with an amorphous fibroareolar space between them. The intertransversalis fascia approach in ULOs is the approach between the 2 layers of the TF.

Conclusions: The intertransversalis fascia approach is described for the first time, to our knowledge. Surgeons can obtain a clean, clear, and bloodless operating space in ULOs using the intertransversalis fascia approach.

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trocars are then inserted under the laparoscopic view. The other trocar is connected with a pressure of 14 mm Hg. Other trocar incision, a 10-mm puncture cannula is inserted 2 cm above the supero border of the iliac crest in the midaxillary line. The laparoscope is placed through the trocar, and the insufflation pressure is maintained at 14 mm Hg. The other trocars are then placed under the guidance and the Hasson technique. The laparoscope is placed through the trocar, and the carbon dioxide insufflator is connected with a pressure of 14 mm Hg. The other trocars are then placed under the laparoscopic view. Then, we divide the urachus high above the bladder using a hook electrocautery device, identify the 2 layers of the TF, and separate the intertransversalis fascia space for further operation (Figure 1C).

Obtaining a Sample for Histologic Examination

A piece of tissue was cut from the abdominal wall in the left middle axillary line below the 12th rib (thickness from the peritoneum to the transversus abdominis) during fresh autopsy.

OUTCOMES

Photographs of the intertransversalis fascia approach in ULOs were taken (Figures 2, 3, and 4). The color atlas of TF anatomy (cross and sagittal sections) was drawn (Figure 5). And the microscopic structure of the TF was observed by microscope (Figure 6).

<table>
<thead>
<tr>
<th>Operation</th>
<th>No.  Performed</th>
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<tbody>
<tr>
<td>Retroperitoneal laparoscopic adrenalectomy</td>
<td>233</td>
</tr>
<tr>
<td>Retroperitoneal laparoscopic (partial) nephrectomy</td>
<td>588</td>
</tr>
<tr>
<td>Retroperitoneal laparoscopic nephroureterectomy</td>
<td>74</td>
</tr>
<tr>
<td>Retroperitoneal laparoscopic pelviliotomomy/ureterolithotomy</td>
<td>15</td>
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<tr>
<td>Retroperitoneal laparoscopic nephropelvisoplasty</td>
<td>34</td>
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<tr>
<td>Retroperitoneal laparoscopic unroofing of kidney cyst</td>
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<tr>
<td>Extraperitoneal laparoscopic radical prostatectomy</td>
<td>76</td>
</tr>
<tr>
<td>Laparoscopic radical/partial cystectomy</td>
<td>32</td>
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<td>Excision of carcinoma of urachus</td>
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<tr>
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<td>13</td>
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<tr>
<td>Laparonephrectomy</td>
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<td>Kidney transplantation</td>
<td>35</td>
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<tr>
<td>Radical/partial cystectomy</td>
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<tr>
<td>Suprapubic prostatectomy</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>1217</td>
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</tbody>
</table>

Laparoscopic hernia repairs 8
Transabdominal preperitoneal repair 2
Total extraperitoneal repair 2
Total 10

COLOR ATLAS OF TF ANATOMY

The TF is a general plane of connective tissue lying between the inner surface of the transversus abdominis and the extraperitoneal fat, and it can be divided into 2 layers: superficial and deep (Figure 5). The superficial layer of the TF closely covers the internal surface of the transversus abdominis and the aponeurosis; thus, dissection between them is relatively difficult. An amorphous fibroareolar space is filled with fat and loose fibrous tissue between the superficial and deep layers of the TF. The fiber matrix in the space becomes thick and dense in the region of the myopectineal orifice, and fatty tissue becomes abundant in the retroperitoneal region. There is also a loose amorphous fibroareolar space between the deep layer of the TF and the peritoneum, which is filled with fat and loose fibrous tissue and contains the medial umbilical ligament, median umbilical ligament, and bladder in the central aspect of the lower anterior abdominal wall.

Superiorly, the 2 layers of the TF fuse and blend with the fasciae covering the inferior surface of the diaphragm. Anteriorly, the superficial layer of the TF forms a continuous sheet covering the inner surface of the transversus abdominis and the posterior rectus sheath (or rectus abdominis), and the deep layer of the TF covers the outer surface of the peritoneum. Posteriorly, the 2 layers join together and form a continuous sheet anterior to the lumbar fascia, but the binding site of these 2 layers keeps moving. For example, these 2 layers join together in the outer edge of the quadratus lumborum muscle on the renal hilum plane and in the outer edge of the psoas major muscle on the third lumbar vertebra plane. Inferiorly, the TF is continuous with the pelvic fascia, which can also be divided into 2 layers. The superficial layer covers the inner surface of the inguinal region, iliaca, psoas major muscle, and external iliac vessels and forms the opening of the deep inguinal ring. The deep layer covers the former half of bladder and prostate and forms a conical sheath around the vas deferens and spermatic vesels in males (or the round ligament of the uterus in females) as the internal spermatic fascia.
INTERTRANSVERSALIS FASCIA Approach in ULOs

The intertransversalis fascia approach is the approach between the 2 layers of the TF. Photographs of the intertransversalis fascia approach were taken during retroperitoneal laparoscopic left nephrectomy (Figure 2), extraperitoneal laparoscopic radical prostatectomy (Figure 3), and transperitoneal laparoscopic partial cystectomy (Figure 4). We can see the superficial and deep layers of the TF, the fat, and the white reticular fibers between the 2 layers. The retroperitoneal space, extraperitoneal space, Retzius space, and Bogros space are parts of the space between the 2 layers of the TF. The inferior epigastric vessels penetrate the superior layer of the TF as it originates from the external iliac vessels and run in the matrix between the 2 layers (Figure 3C) and then they penetrate the superficial layer of the TF at the level of the lineae arcuatae and run into the rectus sheath (Figure 5A–C). Moreover, the superficial branch of the deep dorsal vein of the penis in the Retzius space also penetrates the superior layer of the TF and drains into the deep dorsal vein of the penis (Figures 5D and 3E).

HISTOLOGIC EXAMINATION OF THE TF

Seven layers of structure, from the transversus abdominis to the peritoneum, can be observed under the microscope in the left middle axillary line below the 12th rib (Figure 6). The histologic examination further proves the 2-layer structure of the TF.

COMMENT

In traditional open surgery, surgeons do not adequately assess the TF and fascial spaces, which are usually cut open as a single fascial plane. During the ULO, surgeons need to find the correct potential fascial space and dilate it into a larger space for further operation. Therefore, it is important for surgeons to grasp the anatomy of the TF and fascial spaces. In this study, we described the intertransversalis fascia approach for the first time, to our knowledge, which will help surgeons obtain a clean and clear operating space without hemorrhage during the ULO.

There has been much confusion about the exact definition, anatomy, composition, and significance of the TF and fascial spaces. Cooper originally described the structure of the TF in 1804 as a thin layer of fascia extending upward from the superficial femoral arch (ie, inguinal ligament) and covering the internal surface of the abdominal muscle aponeurosis; then he defined it as the TF in 1844. Some other scholars had different views on the definition of the TF. Skandalakis et al illustrated it as “the entire connective tissue sheet lining the musculature of the abdominal cavity.” Their description was also accepted by Spangen. Braus defined the TF as all the tissue between the transversus abdominis and the peritoneum. Condon noted that the “TF covers the internal surface of the transversus abdominis muscle and aponeurosis, separating them from the underlying preperitoneal fat and peritoneum.” Neil stated in Gray’s Anatomy:

Figure 1. Balloon dilation in the intertransversalis fascia space. A, The balloon dissector is inserted into the intertransversalis fascia space from the incision below the 12th rib in the posterior axillary line. B, The balloon dissector is inserted into the intertransversalis fascia space from the incision at the base of the umbilicus. C, The 2 layers of the transversalis fascia (TF) are separated in the peritoneum. 1 indicates peritoneum (blue); 2, fascial space between the deep layer of the TF and the peritoneum; 3, deep layer of the TF (red); 4, fascial space between the 2 layers of the TF; 5, superficial layer of the TF (green); 6, fascial space between the superficial layer of the TF and the transversus abdominis; 7, transversus abdominis; 8, linea alba; and 9, balloon dissector.

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Figure 2. Intertransversalis fascia approach during retroperitoneal laparoscopic left nephrectomy. A, Posteriorly, the 2 layers of the transversalis fascia (TF) fuse in the outer edge of the quadratus lumbarum muscle. B, Superiorly, the 2 layers of the TF fuse and blend with the fascial covering of the inferior surface of the diaphragm. C, Posteriorly, the binding site of the 2 layers of the TF keeps moving inferiorly and interiorly from the quadratus lumbarum muscle to the psoas major muscle. D, Anteriorly, the 2 layers of the TF fuse in the anterior axillary line and superficially cover the peritoneum in the anterior abdominal wall; deeper to the deep layer of the TF, it is the perirenal fascia near the quadratus lumbarum muscle and the peritoneum near the anterior axillary line. E, Incising the deep layer of the TF near the peritoneal fold and dissecting between the deep layer of the TF and the underlying perirenal fascia, we can then reach the peritoneum. F, Incising the perirenal fascia, we can see the deep perirenal fat. 1 indicates the superficial layer of the TF (covering the interior surface of the transversus abdominis); 2, superficial layer of the TF (covering the anterior surface of the quadratus lumborum muscle); 3, superficial layer of the TF (covering the anterior surface of the psoas major muscle); 4, superficial layer of the TF (covering the inferior surface of the diaphragm); 5, deep layer of the TF (superficially covering the perirenal fascia); 6, deep layer of the TF (superficially covering the peritoneum); 7, deep layer of the TF (superficially covering the peritoneum fold line); 8, binding line of the 2 layers of the TF; 9, white reticular fibers between the 2 layers of the TF; 10, fat between the 2 layers of the TF; 11, peritoneum; 12, perirenal fascia; and 13, perinephric fat.
Figure 3. Intertransversalis fascia approach during extraperitoneal laparoscopic radical prostatectomy. A, The space between the 2 layers of the transversalis fascia (TF) in the region of the anterior inferior abdominal wall. B, The space between the 2 layers of the TF in the left anterior inferior abdominal wall. C, The inferior epigastric vessel runs between the 2 layers of the TF. D, The space between the 2 layers of the TF in the left inguinal region. E, Cutting off the superficial branch of the deep dorsal vein of the penis embedded in the fat in the Retzius space. F, Cutting off the superficial branch of the deep dorsal vein of the penis and cleaning up the fat in the Retzius space, then we can then see the deep layer of the TF superficially covering the prostate. 1 Indicates the superficial layer of the TF (covering the interior surface of the rectus abdominis muscle); 2, superficial layer of the TF (covering the interior surface of the transversus abdominis); 3, superficial layer of the TF (covering the interior surface of the pubis); 4, deep layer of the TF (superficially covering the peritoneum); 5, deep layer of the TF (superficially covering the left external iliac vessel); 6, deep layer of the TF (superficially covering the bladder); 7, deep layer of the TF (superficially covering the prostate); 8, white reticular fibers between the 2 layers of the TF; 9, fat between the 2 layers of the TF; 10, left inferior epigastric vessel (running through the space between the 2 layers); 11, left pubic vein; 12, superficial branch of the deep dorsal vein of the penis; 13, Retzius space; and 14, Bogros space.
Figure 4. Intertransversalis fascia approach during transperitoneal laparoscopic partial cystectomy. A, After establishment of pneumoperitoneum, we can see the posterior aspect of the median umbilical ligament and the bladder. B, The peritoneum and urachus are incised, and the transversalis fascia (TF) is exposed. C, The TF is incised, and the rectus abdominis is exposed. D, The 2 layers of the TF are identified. E, The space between the 2 layers of the TF was bluntly separated. F, We can reach the Retzius space between the 2 layers of the TF. 1 indicates peritoneum (covering the interior surface of the median umbilical ligament); 2, peritoneum (covering the interior surface of the bladder); 3, peritoneum; 4, fat between the peritoneum and the deep layer of the TF; 5, deep layer of the TF; 6, superficial layer of the TF; 7, white reticular fibers between the 2 layers of the TF; 8, fat between the 2 layers of the TF; 9, rectus abdominis muscle; 10, white reticular fibers between the rectus abdominis muscle and the superficial layer of the TF; and 11, pubis.
Figure 5. Clinical anatomy of the transversalis fascia (TF). A, Cross plane below the 12th rib. B, Cross plane of the anterior superior iliac spine. C, Cross plane above the deep ring. D, Cross plane of the superior border of the pubic symphysis. E, Sagittal plane from the linea alba. 1 indicates peritoneum (blue); 2, fascial space between the deep layer of the TF and the peritoneum; 3, deep layer of the TF (red); 4, fascial space between the 2 layers of the TF; 5, superficial layer of the TF (green); 6, fascial space between the superficial layer of the TF and the transversus abdominis; 7, transversus abdominis; 8, obliquus internus abdominis muscle; 9, obliquus externus abdominis muscle; 10, linea alba; 11, inferior epigastric artery; 12, posterior rectus sheath; 13, rectus abdominis muscle; 14, anterior rectus sheath; 15, abdominal cavity; 16, colon; 17, Gerota (perirenal) fascia; 18, perinephric fat; 19, left kidney; 20, fascia lumbodorsalis; 21, latissimus dorsi muscle; 22, quadratus lumborum muscle; 23, psoas major muscle; 24, iliacus; 25, left common iliac artery; 26, left external iliac vein; 27, left gonadal artery; 28, iliohypogastric nerve; 29, sartorius muscle; 30, rectum; 31, obturator internus muscle; 32, levator ani muscle; 33, coccyx; 34, right seminal vesicle; 35, prostate; 36, bladder; 37, obturator vein; 38, pubis; 39, obturator externus muscle; 40, median umbilical ligament; 41, medial umbilical ligament; 42, umbilicus; 43, Retzius space; 44, Bogros space; 45, retroperitoneal fat; 46, vas deferens; 47, superficial branch of the deep dorsal vein of the penis; and 48, pubic symphysis.
characterized the TF as sometimes being bilaminar and penetrate the posterior layer of the TF. Moreover, Anson et al13 and Arregui14 named the posterior layer of the TF as the preperitoneal fascia. Mackay8 stated that the TF is a single-layer structure. Read10 described 2 laminae of the TF inserting into the Cooper ligament, with the epigastric vessels lying in between. However, some scholars, such as McVay and Anson11 and Condon,12 believed that the TF is a single-layer structure. Moreover, Anson et al13 and Arregui14 named the posterior layer of the TF as the preperitoneal fascia.

Cooper2,3 originally described the TF as a bilaminar structure. Mackay,4 Morton,5 and Read10 also agreed with the bilaminar structure of the TF. Mackay5 characterized the TF as sometimes being bilaminar, with the epigastric vessels lying in between. Read10 described 2 laminae of the TF inserting into the Cooper ligament, with the inferior epigastric vasculature in between. However, some scholars, such as McVay and Anson11 and Condon,12 believed that the TF is a single-layer structure. Moreover, Anson et al13 and Arregui14 named the posterior layer of the TF as the preperitoneal fascia. The TF in the anterior inferior abdominal wall and the groin region was mainly involved in these previous studies, which were related to hernia and abdominal wall surgery. However, the TF in the retroperitoneal region has not been mentioned in these studies.

Qiu et al15 studied the clinical anatomy of fasciae and fascial spaces in the retroperitoneal cavity by analyzing retroperitoneal laparoscopic operations, computed tomographs and magnetic resonance images of patients, and fresh autopsies. They found that the lateral conal fascia covered the superficial surface of the posterior layer of the perirenal fascia and that the TF covered the inner surface of the transversalis abdominis. Posteriorly, the lateral conal fascia and the TF fused at the lateral edge of the quadratus lumborum muscle. Anteriorly, the 2 layers fused in the anterior axillary line. In addition, lateral conal fascia and the TF encircled the pararenal fat, and the cavity formed by these 2 fasciae was called the pararenal space. However, their study was localized to the retroperitoneal cavity, which did not extend to the anterior abdominal wall.

By summarizing these former scholars’ research outputs, combining the knowledge of urology and hernia and abdominal surgery, and breaking the limits of different disciplines, we explored the layers, range, and structure of the TF in its entirety and established the theory of the intertransversalis fascia approach for ULOs for the first time, to our knowledge.

With laparoscopic exploration, structures are magnified, and the various fascial planes are more clearly defined with blood flow. In open operations, the operating field is limited, but the anatomical features of the fasciae and fascial spaces in local areas can be further confirmed. Using fresh cadavers, the fasciae are pale, easily disrupted, and difficult to distinguish without the advantage of blood flow, but the operating field is unlimited. Therefore, we can obtain a more comprehensive picture of the TF and fascial spaces by combining these 3 methods.

The results of the present study support the opinion that the TF is a general plane of connective tissue lying between the inner surface of the transversus abdominis and extraperitoneal fat. Moreover, it is a complex 3-dimensional structure with 2 layers of fascia and an amorphous fibroareolar space filled with fat and loose fibrous tissue between them. Retroperitoneal laparoscopic left nephrectomy, extraperitoneal laparoscopic radical prostatectomy, transperitoneal laparoscopic partial cystectomy, and total extraperitoneal repair of hernia are actually accomplished via the intertransversalis fascia approach.

In fact, the retroperitoneal space, extraperitoneal space, Retzius space, and Bogros space comprise different parts of the space between the 2 layers of the TF. The fat between the 2 layers of the TF in the retroperitoneal region has been recognized as retroperitoneal fat or pararenal fat.15 Moreover, the deep layer of the TF has been named the preperitoneal fascia11,14 or the lateral conal fascia.15 The inferior epigastric vessels and the superficial branch of the deep dorsal vein of the penis travel between these 2 layers. The matrix in the space between the 2 layers of the TF is asymmetrical. For example, near the level of the umbilicus lateral to the umbilical folds, the 2 layers of the TF are intimately fused, and the intervening fatty tissue is sparse. The fibrous tissue between the 2 layers of the TF becomes thick and dense in the region of the myopectineal orifice, which can withstand abdominal pressure and prevent hernia. The intervening fatty tissue becomes abundant in the retroperitoneal region, which can protect the kidneys and ureters from external bumping.

In conclusion, the TF is a complex 3-dimensional structure. It can be divided into 2 layers, superficial and deep, with an amorphous fibroareolar space between them. The intertransversalis fascia approach in ULOs is an approach between the 2 layers of the TF. Surgeons can obtain a clean, clear, and bloodless operating space in ULOs using the intertransversalis fascia approach.

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The intertransversalis fascia approach may be a further refinement for the laparoscopic surgeon who already has experience using a retropertioneal approach. Li et al make a valuable contribution through their detailed work to illustrate the precise anatomical plane that may be key to a successful outcome. If one is going to take an alternative route to the mountaintop, it makes sense to have a better understanding of the terrain.

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