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A Study of Fascia and Space Anatomy Layers about Adrenal Gland-Sparing in Retroperitoneal Laparoscopic Radical Nephrectomy

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Abstract

Objective

The objective of this study was to study fascia and space anatomy layers in retro peritoneum, in order to find a modified method in bloodless and the anatomical retroperitoneal laparoscopic radical nephrectomy, and improve operation skills about adrenal gland-sparing.

Methods

From march 2016 to march 2017, a total of 61 patients with localized renal cell carcinoma were analysed, 38 tumors were located in left kidney, and 23 in the right kidney, the diameter of renal tumor was 3.4-7.5 cm, with the mean diameter was 5.6 cm, we complement bloodless and the anatomical operation by exposing and separating relatively bloodless planes such as anterior pararenal space, pre-psoas space, the space between anterior lamella and prerenal fusion fascia, and all patients underwent adrenal gland-sparing surgery based on the theory of fascia and space anatomy layers.

Results

All 61 operations were successfully operated, with no case transferred to open operation. The mean operative time was 66 min(range from 45 to 99 min), and the mean intraoperative blood loss was 80 ml (range from 25 to 160 ml), all patients discharged from hospital on 4 to 7 days after surgery, the mean postoperative hospital stay was 5 days. Adrenal gland laceration and slight bleeding were 5 cases, no case had blood transfusion and other severe complications during surgery.

Conclusions

On the basis of fascia and space anatomy layers in retroperitoneum, through identifying and separating relatively bloodless planes such as anterior pararenal space, pre-psoas space, the space between anterior lamella and prerenal fusion, we can expose the operation space, renal and adjacent organs can be discrimination directly, and adrenal gland-sparing is easier to perform, so we can complement operation bloodlessly and anatomically. This method is a safe and effective procedure, it can decrease operation time, blood loss and complication rates effectively.

Keywords: Retroperitoneal laparoscopy; Radical nephrectomy; Adrenal gland-sparing; Fascia, Space anatomy layers

Introduction

Nowadays, retroperitoneal laparoscopic radical nephrectomy (LRN) has been accepted as the gold standard for the treatment of localized renal cell carcinoma (RCC), homolateral adrenal gland did not need to be removed in most cases, one of the most fundamental step is how to spare adrenal gland. Improper operation would lead to adrenal gland laceration and bleeding, and other severe complications during surgery, which may be due to the separation of the adrenal gland from the kidney. Unfortunately, little study has been done on fastly and safely adrenal gland-sparing in retroperitoneal LPN. We developed a modified technique of adrenal gland-sparing based on the theory of fascia and space anatomy layers, in the present study, we would describe this novel method as follows.

Materials and Methods

Subjects

From March 2016 to March 2017, a total of 61 patients with localized RCC were treated at the department of urology, the first affiliated hospital of Dalian medical university, China, including 48 male and 13 female cases, and their average age was 63.51 years old. 38 tumors were located in left kidney and 23 in the right kidney. The diameter of renal tumor was 3.4-7.5 cm, with the mean diameter was

5.6 cm, 42 tumors were pathologic stage T1N0M0 and 13 were stage T2N0M0, 6 were stage T3N0M0. Ultrasonography and computed tomography were used to identify the renal mass and excluded local lymph nodes and distant metastasis. Examination with intraudio videoenous urography (IVU) and emission computed tomography (ECT) verified normal function of the contralateral kidney. In detail, all tumors were not suitable for partial nephrectomy. Adrenal gland need to be reserved due to the tumor was located in the lower-middle part of the kidney or was a small mass.

Operation methods

Trocar placement and establishment of retroperitoneal space: Preoperative mechanical bowel preparation was performed, and the operation was performed by adopting tracheal intubation for general anesthesia. The patients were placed in a lateral position in order to elevate the kidney. Patients' affected sides were in a semi-oblique position and at 90° to the bed. A 1.5 cm mid-axillary line incision was made by two transverse fingers above the crista iliac, skin and subcutaneous tissue were cut in sequence, the muscle and lumbodorsal fasciae were then dissected with vessel forceps, the retroperitoneal space was entered by blunt finger dissection, and pushing the peritoneum ventrally. A lactoprene balloon was placed, injected with 300 ml air and then removed. A 12 mm trocar was placed in this site, under direct vision, a 12 mm trocar was placed below the costa margin in the posterior axillary line and a 5 mm trocar was placed below the costa margin in the anterior axillary line. Then, CO_2 was injected into the retroperitoneum to establish a retroperitoneal space (air pressure: 12 to 14 mmHg), and the corresponding surgical instruments were placed.

Modified surgical technique for dissection of the kidney and disconnection of renal pedicle: Based on the theory of fascia and space anatomy layers (Figures 1 and 3), Step 1, we dissected through the ex-pararenal fat space between pararenal fat and transverse abdominis and diaphragm to enlarge retroperitoneum. Step 2, found anterior pararenal space among lateral conal fascia, prerenal fusion fascia and peritoneum near the rear abdominal wall, extraperitoneal adipose tissues were resected using the ultrasonic scalpel to facilitate operation, and lateral conal fascia was exposed (Figure 6). Step 3, the lateral conal fascia and posterior lamella of renal fascia were incised widely along the border of quadratus lumborum surface, which can help to provide adequate spacing, up to below the diaphragm, down to the iliac fossa. Finding vessel-less fascia planes (plane of pre-psoas) between posterior renal fascia, fascia psoica and lateral conal fascia (Figure 5). Step 4, dissected upper and lower of kidney dorsal side in plane of pre-psoas, inward to posterior renal hilum, lifted kidney in the middle part, meanwhile, we could find renal arterial pulsation near the inner side of medial arcuate ligament. Step 5, the renal artery was bluntly separated and was clipped with Hem-O-Lock (two in proximal part and one in distal end), then was disconnected.

After the subsidence of the renal vein and the color of the kidney were examined, the renal vein was then ligated with Hem-O-Lock and cut as explained above. Step 6, ureter was separated and ligated with Hem-O-Lock near iliac blood vessels, after that, we dissected ureter using the ultrasonic scalpel. Step 7, resected lateral conal fascia outside of peritoneal reflection, separated to the front of the renal hilum between anterior lamella of renal fascia and prerenal fusion fascia and the lower and upper pole and medial side of the kidney abdominal side were extensively mobilized.

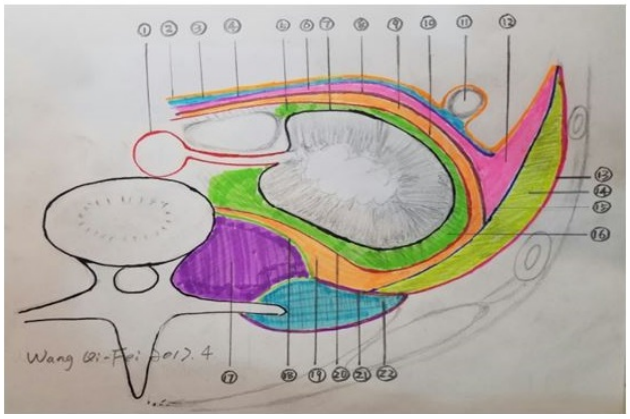

Figure 1: Fascia and space anatomy layers in retroperitoneum. 1. Aorta: Red line; 2. Peritoneum: Orange line; 3. Anterior colon fusion fascia space: Blue area; 4. Colon fusion fascia: Purple line; 5. Perirenal fat: Green area; 6. Anterior prerenal fusion fascia space: Pink area; 7. Renal capsule: Black line; 8. Prerenal fusion fascia: Brown line; 9. Space between anterior lamella and prerenal fusion fascia: Orange area; 10. Anterior lamella of renal fascia: Red line; 11. Colon: Grey area; 12. Anterior pararenal space: Pink area; 13. Transverse fascia: Pink line; 14. Pararenal space/pararenal fat: Light green area; 15. Lateral conal fascia: Blue line; 16. Perirenal fat: Green area; 17. Psoas major: Purple area; 18. Psoas major fascia: Green line; 19. Pre-psoas space: Orange area; 20. Posterior lamella: Red line; 21. Quadratus lumborum fascia: Purple line; 22. Quadratus lumborum: Blue area.

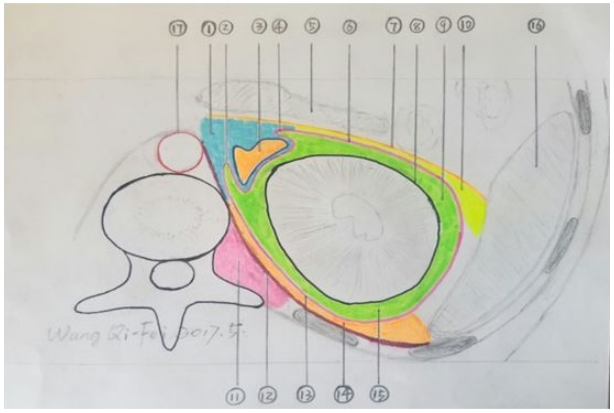

Figure 2: Fascia and space anatomy layers in retroperitoneum. 1. Periadrenal fat: Blue area; 2. Rear reflection of renal fascia: Pink line; 3. Adrenal gland: Orange area; 4. Anterior reflection of renal fascia: Pink line; 5. Pancreas; 6. Anterior lamella of renal fascia: Pink line; 7. Prerenal fusion fascia: Orange line; 8. Renal capsuleblack line; 9. Perirenal fat: Green area; 10. Space between anterior lamella and prerenal fusion fascia: Yellow-green area; 11. Psoas major: Pink area; 12. Psoas major fascia: Purple line, 13. Posterior lamella: Pink line; 14. Pre-psoas space: Orange area; 15. Perirenal fat: Green area; 16. Spleen; 17. Aorta: Red line.

Figure 3: CT scan of kidney. 1. Renal fascia: Green line; 2. Psoas major fascia and transverse fascia: Yellow line; 3. Lateral conal fascia: Red line; 4. Prerenal fusion fascia: Pink line; 5. Colon fusion fascia: Blue line; 6. Peritoneum: Light blue line.

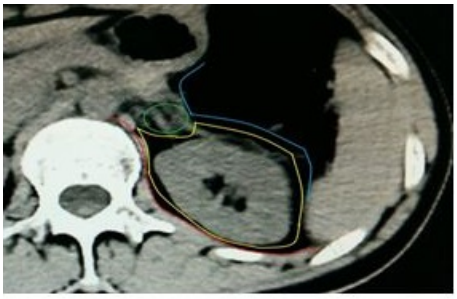

Figure 4: CT scan of upper of kidney and adrenal gland. 1. Renal fascia: Yellow line; 2. Adreanal gland: Green circle; 3. Psoas major fascia: Red line; 4. Prerenal fusion fascia: Blue line.

Modified surgical technique of adrenal gland-sparing: After disconnection of the renal pedicle vessels, separated to the bottom of the adrenal gland along interior surface of kidney via the plane of the disconnected renal pedicle, elevate upper of kidney by the convenience of renal pedicle vessels disconnection, make it had a certain tension between the adrenal gland and upper of kidney, then separated the upper of the kidney to the bottom of the adrenal gland at horizontal field of view, and then mobilized forward to the anterior fusion fascia, backward to the diaphragm foot and fascia along this plane, the adrenal gland can be completely separated from the renal fascia and perirenal fat (Figure 8). Lastly, the anterior part of the renal fascia was separated from the anterior renal fusion fascia, so that the kidney could mobilize completely. This modified surgical technique of adrenal gland-sparing that based on the theory of fascia and space anatomy layers in retroperitoneum is an innovation, which could make the operation complete under direct vision on a horizontal plane, reduce the risk of adrenal tear and bleeding, clarify the anatomical level, lead to less operation time and intraoperative blood loss compared to the traditional process.

Extraction of the specimen: The incised kidney and surrounding tissues were placed into the extraction bag, made a mini-incision from the site that trocar in posterior axillary line to its below and anterior, about 5-6 cm, it should be noted that the mini-incision could not be connected to the site that trocar above the crista iliac, after that, it easy to rotate and pull out the specimen slowly. This technique could shorten the length of the incision effectively [1]. Then the skin incision was closed after a drainage tube was placed in site of trocar above the crista iliac.

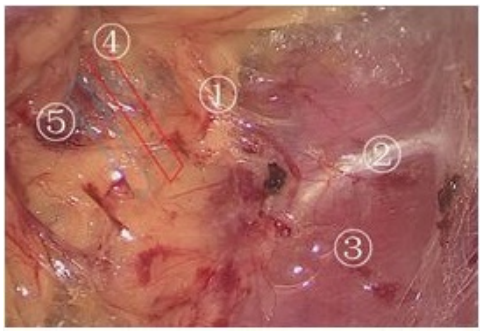

Figure 5: Pre-psoas space. 1. Posterior lamella and perirenal fat; 2. Arcuate ligament; 3. Psoas major; 4. Projection of aorta: Red area; 5. Projection of vena cava: Blue area.

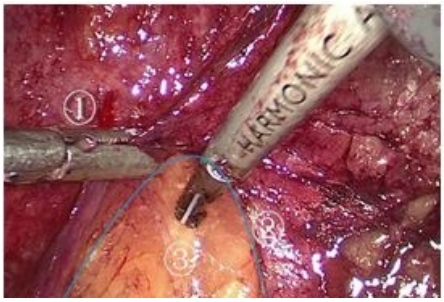

Figure 6: Anterior pararenal space. 1. Prerenal fusion fascia; 2. Lateral conal fascia: Blue line; 3. Pararenal fat.

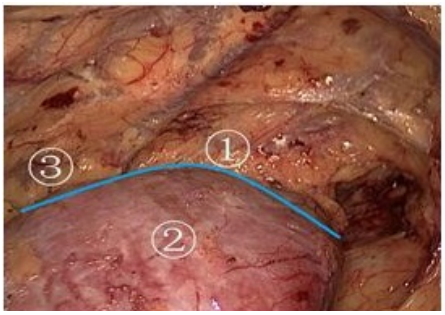

Figure 7: Subphrenic space. 1. Adrenal gland; 2. Kidney (left); 3. Radian measure in the upper pole of kidney: Blue line.

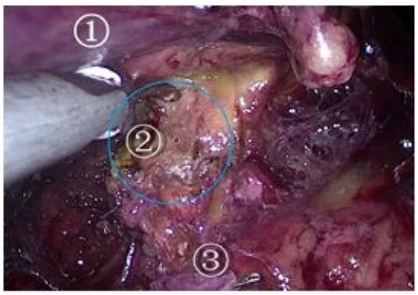

Figure 8: Separate adrenal gland via renal pedicle vessels incision plane. 1. Kidney (left); 2. Adrenal gland: Blue circle; 3. Lacerated end of renal artery.

Results

All 61 operations were successfully operated, with no procedure required conversion to open surgery. The mean operative time was 66 min (range from 45 to 99 min), and the mean intraoperative blood loss was 80 ml (range from 25 to 160 ml). Antibiotics were administered 1 to 2 days after surgery to avoid infection. The drainage tube was removed 2 to 3 days after surgery on the condition that no liquid outflow. All patients discharged from the hospital on 4 to 7 days after surgery, the mean postoperative hospital stay was 5 days. Adrenal gland laceration and slight bleeding were 5 cases, the peritoneum ruptures were 3 cases and no case had blood transfusion and other severe complications during surgery. The recovery eating time ranged from 10 to 23 hours post operation. Patients were allowed to exit bed 24 to 48h after the operation. All patients were confirmed via postoperative pathology, of the 61 tumors, 52 cases were clear cell tumors, 5 cases were papillary tumors, 4 cases were chromophobe cell tumor. 55 patients were followed up, the mean follow-up time was 15 months (ranged from 1 to 29 months), the examination included routine blood and urine tests, hepatic and renal function, chest radiograph and abdomen ultrasonography and CT examination, all of above items no obvious abnormal, and no local recurrence and distant metastasis were visible via CT scan and chest X-ray examination.

Discussion

Theoretical basis of fascia and space anatomy layers in retro peritoneum

According to the theory of fascia and space anatomy layers, retroperitoneal space can be divided by anterior and posterior renal fascia into the space of anterior renal fusion fascia, the space of renal fascia and the space of adrenal glands [2]. Adrenal gland is not located in kidney within perirenal fat, it is located outside the renal fascia cavity, which is in the space of adrenal glands located in the anterior internal side of renal fascia space, the renal fusion fascia is in the front of the adrenal glands space, diaphragm is in the back of the adrenal glands space, the outer boundary of the space is renal fascia [3]. Posterior renal fascia composed of superficial layer (lateral conal fascia) and the deep one (posterior lamella), prerenal fascia composed of anterior lamella and prerenal fusion fascia (Figure 1).

Retroperitoneoscopic surgery has been widely used as a mature technology nowadays, and many reports have presented the results of retaining adrenal gland, when tumors are located in the lower-middle part of the kidney and tumors diameter are less than 6 cm, the main step of the procedure is the management of the adrenal gland, improper operation would lead to adrenal gland laceration and bleeding and other severe complications during surgery [4]. One of the most urgent problem needs to be solved is how to dissect the adrenal gland safely and quickly in retroperitoneal LRN. The key to succeed in operation is that identification of fascia and space anatomy layers, and separating in relatively bloodless planes [5]. Based on the theory of fascia and space anatomy layers in retro peritoneum, after establishment and enlargement of retroperitoneal space, we could find anterior pararenal space among lateral conal fascia, prerenal fusion fascia and peritoneum near the rear abdominal wall, find pararenal space between lateral conal fascia and transverse fascia, extraperitoneal adipose tissues were resected to facilitate operation. Incised the lateral conal fascia, it must be noted that traditional view considered lateral conal fascia was extension of renal fascia [6], however, through the study of fascia and space anatomy layers in retroperitoneal, we found that lateral conal fascia was extension of psoas fascia. Posterior lamella and anterior lamella of renal fascia were smooth and uniformly continuous, they enveloped kidney and perirenal fat together, so space of renal fascia was a closed interspace [7]. After lateral conal fascia was incised, we could find the plane of pre-psoas, which was a relatively bloodless planes, and separated upper and lower of kidney, then some white and netted fibrous bands could be found, it was important anatomical mark. It is notable that did not separate upper of kidney completely, the reason is that conjoint tissues between the upper of kidney and subphrenic were natural hammock, it could make kidney to keep suspension, which can contribute to separate kidney and renal pedicle. Then, exposed and disconnected renal artery and renal vein. After disconnection of renal pedicle, found the space between anterior lamella and prerenal fusion fascia, separation in these relatively bloodless planes could avoid bleeding and other adjacent organ injury.

Modified surgical technique of Adrenal gland-sparing based on the theory of fascia and space anatomy layers: There are three planes around adrenal gland, medial plane is diaphragm surface, closed to crura of diaphragm, adipose tissue is less in this plane; facies anterior plane is peritoneum surface, closed to prerenal fusion fascia, adipose tissue is also less in this plane; and lateral plane is kidney surface, closed to upper of kidney, adipose tissue is much in this plane, perirenal fat and periadrenal fat are divided by renal fascia, all of them are relatively bloodless planes [8]. Particularly attention is that the right adrenal central vein converged with the inferior vena cava, while the left adrenal central vein converged into the left renal vein [9]. In traditional process, adrenal gland was separated in three above planes, we need incided perirenal fat on the abdominal side of upper of kidney, and separated in relatively bloodless planes between the bottom of the adrenal gland and the upper of kidney [10]. However, a disadvantage of this technique might be could not avoid the influence of the upper pole of the kidney. Also, we considered that this method needs large scope separation, and influence of fat tissues was a big trouble.

Less reports discussed the adrenal gland-sparing surgery based on the theory of fascia and space anatomy layers, In this study, we try to improve the method of separating adrenal gland on the basis of this theory, so that the adrenal gland can be separated from the perirenal fat capsule more securely and quickly, which can avoid adrenal gland laceration and bleeding. We summarized technical points: the renal fascia is not separated from the anterior renal fascia by conventional methods after disconnection of the renal pedicle vessels, which can

avoid the influence of the dropped kidney on the operating space of the plane of pre-psoas (Figure 7), it can elevate kidney by the convenience of renal pedicle vessels incision, make it has a certain tension between the adrenal glands, then separate the upper part of the kidney to the bottom of the adrenal gland along the renal vascular plane of the renal pedicle, separating the plane of the adrenal gland from the pole of the kidney, and then move forward to the anterior fusion fascia, backward to the diaphragm foot and fascia along this plane, the adrenal gland can be completely separated from the renal fascia and perirenal fat (Figures 2 and 4). Lastly, the anterior part of the renal fascia is separated from the anterior renal fusion fascia, so that the kidney falls. The above method deal with the upper pole of the kidney-adrenal plane before the kidney falls, which can avoid the influence of the radian measure in the upper pole of kidney, it has the advantage such as the operation could be completed under direct vision. Compared to the traditional process, our adrenal gland-sparing surgery was directly performed on a horizontal plane, and the free range is small and the anatomical level is clear, which can reduce the risk of adrenal tear, bleeding and so on. Owing to the advantages above, our modified technique resulted in less operation time and intraoperative blood loss compared with the previous one.

The plane of the fascia is a less vascular plane, a natural surgical plane. Based on the understanding of the anatomy of the retroperitoneal space, we have established technique to free kidney, exposure of renal pedicle, localization and isolation of adrenal gland guided by anatomy. Through clinical practice, we perform surgery according to the anatomical characteristics of the fascial space, free the tissue in less vascular plane, which has the advantage as follows: clear vision, adequate surgical space, the anatomical landmarks are clear, safe and rapid isolation of adrenal glands, the operation can be performed under direct vision without blood dissection surgery, which lead to a significant decrease in the incidence of complications such as adrenal tear, hemorrhage and adjacent organ injury, it can also shorten the operation time, reduce the amount of bleeding, the curative effect is accurate, the prognosis is good, worthy of clinical application, these advantage recommend clinical application. In conclusion, this new technique contributed to less operation time and intraoperative blood loss compared with the previous technique, these observations suggested that this modified technique is safe and feasible for adrenal gland need be reserved in retroperitoneal LRN. However, there are still some limitations of this surgical technique, first of all, it is difficult to dissect the kidney and disconnect the renal pedicle under situation of the metastatic lymphonodus located at renal hilum. What is more, it is a big problem that the adrenal gland is difficult to be separated on the condition that periadrenal adipose tissue conglutinate it around in some obese patients. These issues need further improvement. In our work, follow-up study showed no recurrence and distant metastasis was visible. Admittedly, what we have observed in this study is far from complete and it requires further research with longer follow-up time.

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