

Original Article

A novel approach to locate renal artery during retroperitoneal laparoendoscopic single-site radical nephrectomy

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Abstract: *Objective:* To verify the feasibility and safety of retroperitoneal laparoendoscopic single-site radical nephrectomy and assess the value of our proposed approach to search for renal artery. *Methods:* A total of 60 cases of retroperitoneal laparoendoscopic single-site radical nephrectomy were performed using our homemade single-port multi-channel device. An incision of 5-6 cm was cut forward from the posterior axillary line under the lower margin of the 12th rib, and a single-port multi-channel device comprised of two control rings and a No. 7 glove was placed into the incision. Retroperitoneal laparoendoscopic single-site radical nephrectomy was then performed via locating renal artery through muscle and ligament on the posterior abdominal. *Results:* The 60 cases were all successful. None of the 60 patients developed surgical complications. *Conclusion:* The application of homemade device is safe and feasible. Our proposed method is of greater practical significance for the relatively narrow operating space in retroperitoneal laparoendoscopic single-site surgery.

Keywords: Single-site laparoscopy, nephrectomy, retroperitoneal tumor

Introduction

Laparoscopic technique has been widely applied and popularized in urologic surgery. Routine retroperitoneal laparoscopic technology has been successfully used in treating stage T₁ and T₂ renal cancers, but it requires at least three incisions [1]. By using muscle ligament on the posterior abdominal wall to locate renal hilum and subsequently renal vessels, we have successfully performed 60 cases of retroperitoneal laparoendoscopic single-site radical nephrectomy with homemade single-port multi-channel device and obtained good therapeutic effect, which has been introduced in this report.

Methods

Patient information

From April, 2011 to August, 2012, 60 cases of retroperitoneal laparoendoscopic single-site radical nephrectomy were carried out using homemade single-port multi-channel device. They were 40 males and 20 females, with ages

ranged from 30 to 78 years (mean, 52 years), weight ranged from 48 to 98 kg, height from 150 to 183 cm, and BMI ranged from 19.23 to 31.25 (mean, 24.87). All cases underwent CT or MRI examination. Among these tumors, 38 cases were found in the left kidney, and 22 cases in the right kidney. The maximum tumor diameter ranged from 2.3 to 10.1 cm (mean, 5.16 cm). A total of 56 out of the 60 cases were with renal carcinoma; among these tumor cases, 15, 33, and 8 were in stage T_{1a}, T_{1b}, and T₂, respectively.

Surgical procedures

The patient was under general anesthesia and in a supine position with contralateral side down. An oblique incision of 1.5-2 cm was made from the posterior axillary line under the lower margin of the 12th rib. The retroperitoneal abdominal space was expanded firstly with forefinger and then with balloon dilator. The incision was further extended forward to 5-6 cm and retracted. The extraperitoneal adipose tissue was cleared as much as possible. As

A novel approach to locate renal artery

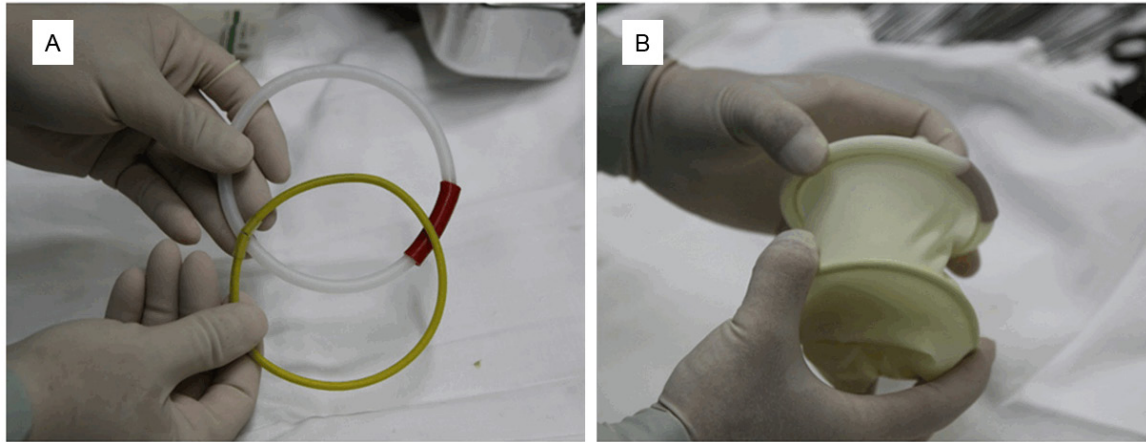


Figure 1. The homemade single-port device. A: The homemade control rings; yellow one is the inner control ring supported by 2 hard guidewires inside, and white one is the outer control ring made of guidewire sheath. B: The homemade single-port device comprised of inner and outer control rings and a No. 7 powder-free surgical glove.

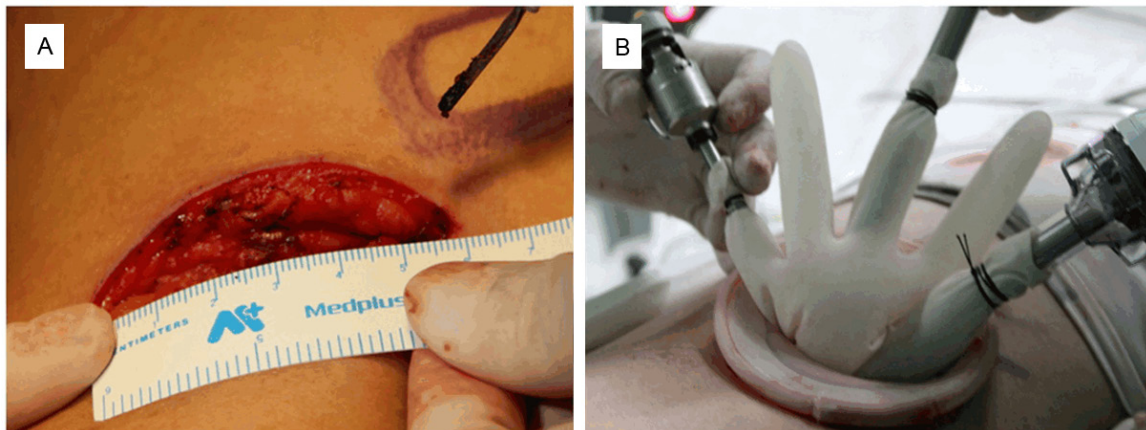


Figure 2. Selected pictures showing the retroperitoneal laparoendoscopic single-site radical nephrectomy. A: 6 cm incision was made inferior and anterior to the 12th rib. B: Operation with single-port multi-channel device.

shown in **Figure 1**, two control rings (9 cm in diameter) and a No. 7 powder-free surgical glove were used to form a single-port multi-channel operation device, which was placed in the incision with inner ring inside the body and outer ring staying outside. The end of the glove's middle finger was cut, and a catheter was put in and fixed. The space was then filled with CO₂ gas; a laparoscopy was placed to observe the operation space. Another two 5 and 12 mm catheters were put in respectively through the glove's little finger and thumb and fixed, through which conventional laparoscopic instruments were set up to carry out the laparoscopic radical nephrectomy (**Figure 2**). The psoas muscle, the diaphragm, the median arcuate ligament, and the diaphragmatic crura

on the posterior abdominal wall were subsequently found to locate the renal hilum, and the renal artery was then located to start the radical nephrectomy (**Figure 3**). After the specimen was removed through the operation port, the incision was routinely sutured.

Results

The retroperitoneal laparoendoscopic single-site radical nephrectomy on this series of 60 patients using homemade single-port multi-channel device was all successful. The homemade equipment showed no obvious air leaks, and there was no need to increase channel or to intraoperatively convert to open surgery. However, there was apparently mutual interfer-

A novel approach to locate renal artery

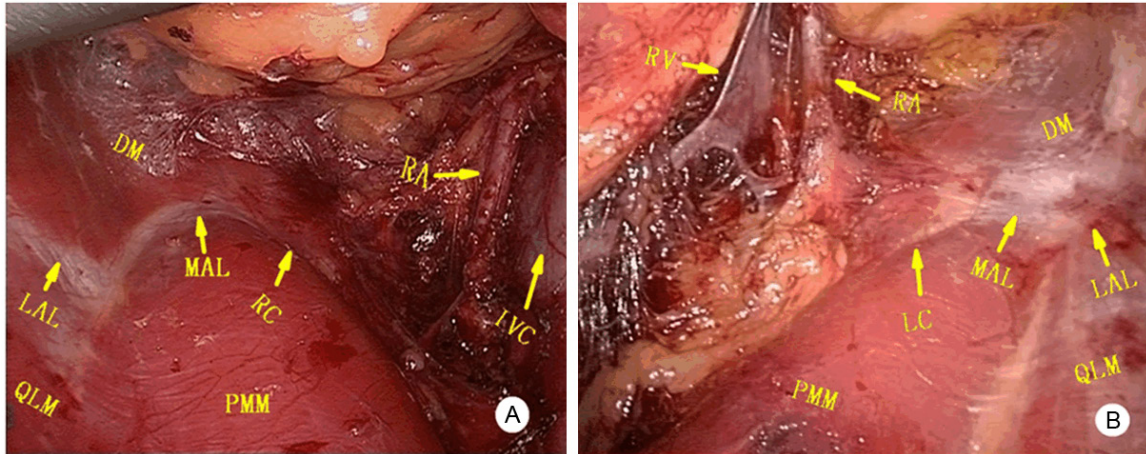


Figure 3. A: The right side of abdominal cavity after exposing the right renal hilum and separating the renal artery; midian arcuate ligament (MAL) at the boundary between the diaphragm and the psoas muscle is transversely close to the renal hilum, and the right diaphragmatic crus and right renal artery run approximately into a V-shaped mirroring position; the renal artery neighbors the inferior vena cava (IVC). B: The left side of abdominal cavity after exposing the left renal hilum and separating the left renal artery; midian arcuate ligament (MAL) at the boundary between the diaphragm and the psoas muscle is transversely close to the renal hilum, and the left diaphragmatic crus and left renal artery run approximately into a V-shaped mirroring position; the separated left renal vein (RV) can be observed too.

ence among the conventional laparoscope and relevant instruments both inside and outside the abdominal cavity. Under laparoscope, six anatomical structures, 3 muscles and 3 ligaments, were subsequently observed on the posterior abdominal wall. They were respectively the posterior abdominal quadratus lumborum, psoas muscle, mid of upper diaphragm, lateral arcuate ligament attached to the surface of quadratus lumborum, median arcuate ligament attached to the surface of psoas muscle (in the middle), and diaphragmatic crura in the most medial side close to the spine. While the median arcuate ligament extending transversely toward the spine direction pointed to the renal hilum, the diaphragmatic crura extending in an arc-shape toward the spine was in a mirroring position to the renal artery (**Figure 3**). In accordance with the positioning of these muscles and ligaments, the renal artery and vein were easily located and processed. The estimated intraoperative blood loss was approximately 20-400 mL. The operation lasted from 1 to 3 hr (average, 2 hr and 11 min). Drainage tube was placed through the incision site and removed after 24-48 hr. The amount of drainage was 15-150 mL. The patients started to get out of bed for activities 1-3 days after the surgery and were discharged after 5-7 days post surgery. This group of 60 patients had no

operation-related complications. Postoperative pathology confirmed that among the 60 cases, 56 were with renal cell carcinoma; 3 cases with renal oncocytoma; and 1 case with angiomyolipoma.

Discussion

With the continuous development of minimally invasive techniques, improved methods for laparoscopic nephrectomy, such as single-port transumbilical nephrectomy and retroperitoneal laparoendoscopic single-site nephrectomy, have been reported [2-8]. The standard surgical treatment of renal cancer needs to resect the kidney and the perirenal fascia and fat sac, sometimes, even the adrenal gland. Currently these surgeries can be successfully completed with regular retroperitoneal laparoendoscopic nephrectomy [1]. However, larger specimens are more difficult to remove through natural channel or umbilical incision. Under the current conditions of technology and equipment, to remove a whole piece of surgical specimen of renal cancer still requires corresponding incision. Therefore, we have designed and used the specimen removal incision to carry out the retroperitoneal laparoscopic radical nephrectomy. The surgery was performed with conventional laparoscopy and operating equipments by comprehensively taking advantage of the

A novel approach to locate renal artery

single specimen removal incision, which avoided the other two incisions required in regular retroperitoneal laparoscopic surgery, retained the advantages of retroperitoneal laparoscopy (conveniently treating renal pedicle and little disturbance to abdominal cavity), and hence achieved the effect of reducing surgical trauma and scars.

Urologists have generally believed for long time that the path for retroperitoneal renal surgery is good and relatively simple, with little disturbance to the abdominal organs. However, the retroperitoneal space is small, with less evident anatomic landmarks, which has limited the scope of its application and especially brought difficulties to the single-port operation. To accurately locate renal hilum and to search and handle renal vessels have become a technical difficulty. Based on clinical research, in this report we used posterior abdominal muscles and ligaments to locate the renal hilum and to further find and process the renal vessels, which appeared to be very convenient and practical with this group of operations. The fixed anatomical structures on posterior abdominal wall are clearly visible under laparoscope and neighbor the dorsal side of kidneys in a relatively fixed position, which provides reference anatomic landmarks for positioning in laparoscopic surgery. In both sides of the retroperitoneal operational space, fascia and adipose tissue are in the fascia side posterior to the kidney. It is relatively difficult to find reference anatomic landmarks in adipose tissue. However, the corresponding posterior abdominal wall is composed with different muscles and ligaments; these structures show a fixed morphology and corresponding positional relationship and also have a relatively fixed positional relationship with kidney, which can be used as reference anatomic landmarks for renal dissection and separation.

This report suggests that under laparoscope, 6 important anatomical structures, 3 muscles and 3 ligaments, on the posterior abdominal wall can be taken as reference anatomic landmarks. During the operation process, observation of the posterior abdominal wall can help to locate the operating position, e.g., seeing the quadratus lumborum prompts a position outside the kidney; the psoas muscle indicates a position close to the middle and lower part of the kidney; the mid of diaphragm prompts that

the laparoscopy is operating above the kidney; seeing the arcuate ligament on the upper surface of psoas muscle indicates that the operation is near the renal hilum, because this ligament extends transversely toward the renal hilum; and the arc-shaped diaphragmatic crus suggests the corresponding travel direction of renal artery. Under laparoscope, retracting the kidney toward medial direction exposes both the structures of diaphragmatic crus and renal artery in a V-shaped mirroring position. Through these structures, the positioning and orientation during the laparoscopic surgery with this group of patients became clear, simple, and convenient, so was the locating of renal hilum and artery. Although the theoretical observation range of single-port multi-channel operation is greater than that of conventional laparoscopy, the actual range becomes smaller in the former when laparoscope and two operating devices operate at the same time. Therefore, to accurately locate the renal hilum is especially important during the operation of single-port laparoscopic surgery.

Local anatomy indicates that renal arteries branch out from both sides of abdominal aorta at the level of lumbar spine 1 and 2. Lateral arcuate ligament, medial arcuate ligament, and diaphragmatic crura are anchors for the mid of diaphragm. The lateral arcuate ligaments are thickened fascia anterior to the quadratus lumborum and attach to the 12th rib and the transverse process of lumbar vertebra 1. The medial arcuate ligaments are thickened fascia anterior to the psoas muscle and attach to the transverse process of lumbar vertebra 1 and the side of lumbar vertebrae 1 and 2 [7]. These structures are anatomically located next to each other, with the same travel direction. Especially, the neighboring relationship between medial arcuate ligaments and renal arteries has a solid anatomical basis. Therefore, operators may use these anatomical structures to achieve positioning under retroperitoneal laparoscope.

We believe that the retroperitoneal laparoendoscopic single-site radical nephrectomy using homemade single-port multi-channel device in this study is safe and feasible, without evident increase in operating difficulties. Meanwhile, the procedure to find and process renal vessels by firstly locating renal hilum through posterior abdominal muscles and ligaments is simple

A novel approach to locate renal artery

and easy. The operation and specimen removal were through the same incision, which avoided the other 2 incisions required for conventional laparoscopic surgery. Trauma and scar from only 1 single incision undoubtedly benefit the patients. Therefore, skilled surgeons may apply retroperitoneal laparoendoscopic single-site radical nephrectomy using the procedure introduced in this study to substitute the conventional laparoscopic techniques.

Disclosure of conflict of interest

None.

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References

- [1] Steinberg AP, Finelli A, Desai MM, Abreu SC, Ramani AP, Spaliviero M, Rybicki L, Kaouk J, Novick AC, Gill IS. Laparoscopic radical nephrectomy for large (greater than 7 cm, T₂) renal tumors. *J Urol* 2004; 172: 2172-2176.
- [2] Desai MM, Rao PP, Aron M, Pascal-Haber G, Desai MR, Mishra S, Kaouk JH, Gill IS. Scarless single port transumbilical nephrectomy and pyeloplasty: First clinical report. *BJU Int* 2008; 101: 83-88.
- [3] Kaouk JH, Haber GP, Goel RK, Desai MM, Aron M, Rackley RR, Moore C, Gill IS. Single-Port laparoscopic surgery in urology: initial experience. *Urology* 2008; 71: 3-6.
- [4] Nozaki T, Watanabe A, Fuse H. Laparoendoscopic single-site surgery for partial nephrectomy without ischemia using a microwave tissue coagulator. *Surg Innov* 2013; 20: 439-443.
- [5] Desai MM, Berger AK, Brandina R, Aron M, Irwin BH, Canes D, Desai MR, Rao PP, Sotelo R, Stein R, Gill IS. Laparoendoscopic single-site surgery: initial hundred patients. *Urology* 2009; 74: 805-812.
- [6] Han WK, Park YH, Jeon HG, Jeong W, Rha KH, Choi H, Kim HH. The feasibility of laparoendoscopic single-site nephrectomy: initial experience using homemade single-port device. *Urology* 2010; 76: 862-865.
- [7] Ryu DS, Park WJ, Oh TH. Retroperitoneal laparoendoscopic single-site surgery in urology: initial experience. *J Endourol* 2009; 23: 1857-1862.
- [8] Lee SW, Lee JY. Laparoendoscopic single-site urological surgery using a homemade single port device: The first 70 cases performed at a single center by one surgeon. *J Endourol* 2011; 25: 257-264.