Direct Upper Kidney Pole Access and Early Ligation of Renal Pedicle Significantly Facilitates Transperitoneal Laparoscopic Nephrectomy Procedures: Tunc Technique

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Abstract: We modified our technique in transperitoneal laparoscopic nephrectomies and compared its results with the classical technique. Classical technique was performed in 85 cases (group 1). Modified technique (n = 98) included direct kidney upper pole access and early ligation of renal pedicle (group 2). No significant differences were detected regarding mean patient age, intraoperative blood loss, and duration of hospital stay between the 2 groups ($P > 0.05$). Mean operation time was 64.9 ± 19.3 and 28.2 ± 7.7 minutes, respectively in groups 1 and 2 ($P = 0.001$). Mean operation time including right nephrectomies was 68.7 ± 23.4 and 24.2 ± 6.3 minutes, respectively in groups 1 and 2 ($P = 0.001$). Mean operation time including left nephrectomies was 63.8 ± 17.1 and 33.6 ± 5.1 minutes, respectively in groups 1 and 2 ($P = 0.001$). Similarly, mean operation time was significantly shorter in group 2 when analysis was performed among right and left radical and simple nephrectomies between the 2 groups ($P = 0.001$). Direct upper kidney pole access and early ligation of renal pedicle seems to be significantly facilitating transperitoneal laparoscopic nephrectomy procedures.

Key Words: transperitoneal laparoscopic nephrectomy, technical modification, operation time, experience, surgical outcomes

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After the introduction of laparoscopic nephrectomy[1,2] in 1991, many centers have reported their results regarding the advantages of laparoscopic approach compared with open technique.[3–5]

Robson[6] was the first who described open radical nephrectomy (RN) in the treatment of renal cell carcinoma (RCC), which has been the gold standard method, although the Robson criteria for RN have now historical interest. Currently, laparoscopic radical nephrectomy (LRN) is recommended as a standard surgical approach for T1b-T2 RCC disease and as a feasible surgical approach in selected patients with T3, T4 disease by the European Association of Urology Guidelines.[7] In the classical surgical urology textbooks, standard transperitoneal nephrectomy technique involves the following surgical steps after peritoneal insufflation and port placement: (a) mobilization of the colon; (b) dissection of the ureter; (c) dissection of the lower renal pole: (d) dissection of the renal hilum; (e) identification and skeletonization of the renal artery and vein; (f) occlusion and division of these vessels: (g) completion of nephrectomy dissection; and (h) finally entrapment and removal of the specimen.[8,9]

Although early ligation of the renal artery and vein is one of the most critical steps of RN to prevent diffusion of malignant cells as described by Robson,[6] this important step is not performed initially in the published literature.[8–11] Recently, Porpiglia et al[12–14] reported their experience with direct access to renal artery at the level of Treitz ligament during transperitoneal "left" LRN.

Although initially we used the standard technique as described above,[8,9] after performing a certain number of cases including transperitoneal LRN, laparoscopic nephroureterectomy (LNU), and simple nephrectomy (LSN) procedures, we modified our technique which basically includes direct access to the renal pedicle and early ligation of renal artery and vein including right and left transperitoneal LRN, LNU, and LSN procedures. Herein, we describe our modified technique and compared its results with the standard established procedure.

MATERIALS AND METHODS

Between February 2004 and April 2010, we performed 96 transperitoneal LRN procedures due to RCC, 10 transperitoneal LNU procedures due to upper urinary tract transitional cell carcinoma, and 77 transperitoneal LSN procedures due to nonfunctioning kidney at Gazi University School of Medicine, Department of Urology. All of the procedures were performed by a single surgeon (L.T.) and assisted by a urologist or a urology resident. Transperitoneal nephrectomy procedures that we performed at other institutions to demonstrate our technique were also included in this study. Patients with previous kidney surgery (laparoscopic/open), patients with hilar lymphadenopathy in addition to renal mass, patients with renal vein thrombus, and patients who underwent nephron-sparing surgery were excluded. Regional lymph node dissection was not performed in any of the patients. Whenever technically feasible, nephron-sparing surgery was performed for solitary renal tumors up to a diameter of 7 cm due to the European Association of Urology guidelines.

Trocar Placement

First trocar (12 mm) was located 4 cm lateral and superior to the umbilicus using the Hasson technique after peritoneal insufflation. The second trocar (12 mm) was

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inserted 8 cm lateral to the umbilicus. The last trocar (12 mm) was located 3 cm superior and 1 to 2 cm lateral to the first trocar that corresponds 1 to 1.5 cm below costal margin. Trocars form a triangle on the abdomen. The fourth trocar (5 mm) was optional and was placed below the xiphoid. Location of the trocars might slightly change due to the body mass index of the patient.

Standard Surgical Technique

First 85 cases were performed by using the standard technique described in classical laparoscopic urology books.[8,9] A Foley catheter and a nasogastric tube were inserted and patients were placed in the lateral decubitus position. The surgical steps included (a) mobilization of the colon, (b) dissection of the ureter, (c) dissection of the lower renal pole, (d) dissection of the renal hilum, (e) identification and skeletonization of the renal artery and vein, (f) occlusion and division of these vessels either by vascular stapler [EndoGIA Universal Straight, Autosuture (45-2.5), Covidien] or by endoclips (Hem-o-Lok polymer clip, Weck Closure Systems, Research Triangle Park, NC), (g) completion of nephrectomy dissection, and (h) finally entrapment of the kidney in the endobag and removal of the specimen. A drain was left in place.

Modified Surgical Technique

As our experience increased, we modified our technique. Patient positioning and trocar sites were the same as explained above. However, in our modified technique involving 98 patients, colon was not mobilized in right nephrectomies, whereas colon mobilization was performed in left nephrectomies. Regarding right nephrectomy procedures, next steps included exposing the upper kidney pole and entering the Morison space (hepatorenal recess or subhepatic recess), which is the space that separates the liver from the right kidney. To reach the Morison space, the part of the peritoneum immediately under the liver was incised from triangular ligament to the vena cava. Entering this space easily detaches the right kidney upper pole from the surrounding structures. Renal hilar structures including renal artery and vein were identified, ligated, and cut as explained above. Thereafter, kidney was mobilized from lower pole and ureter was identified and cut after applying endoclips. After completion of the nephrectomy dissection, specimen was removed in the endobag. Regarding left nephrectomy procedures, after exposing the upper kidney pole, renal hilar structures including renal artery and vein were identified, ligated, and cut and rest of the procedure is same as explained above. Attention was paid during mobilization of the upper pole kidneys bearing a tumor.

We had 3 patients in group 1 (Standard technique) and 4 patients in group 2 (Modified technique) in whom we detected multiple arteries and veins during renal hilum dissection. We used vascular stapler in 2 patients in group 1 and in 3 patients in group 2 and we did not have any problems. In the remaining 1 patient in each group, multiple arteries and veins were dissected separately and endoclips (Large Hem-o-Lok polymer clips) were used in their occlusion and division.

Group 1 included 85 cases and group 2 included 98 cases. Mean operation time, mean blood loss, and duration of hospital stay were compared between the groups. All of the procedures were performed by a single surgeon (L.T.) starting from trocar insertion and placement of the kidney into the endobag. Because extraction of the specimens and closure of the incisions and port sites were performed by the assistant (a urologist or a urology resident) in most of the procedures, operation time was calculated between trocar insertion and placement of the kidney into the endobag, which was performed in all cases by a single surgeon (L.T.). Regarding the nephroureterectomy procedures (n = 10), operation time involving the nephrectomy part is included in the analysis. Operation time involving ureterectomy, bladder preparation, and cuff excision was not included in the analysis. Tumor size was measured postoperatively during pathologic evaluation. Statistical analysis was performed by using Student t tests and Mann-Whitney U tests. $P < 0.05$ was regarded as statistically significant.

RESULTS

Mean patient age was 49.6 ± 4.2 and 50.3 ± 3.7 years, respectively in groups 1 and 2. Mean tumor size was 7.2 ± 1.7 cm (range, 3 to 11 cm) and 6.8 ± 1.8 cm (range, 3.4 to 10.6 cm), respectively in groups 1 and 2. Mean intraoperative blood loss was 150 ± 30 and 40 ± 10 mL, respectively in groups 1 and 2. Duration of hospital stay was 2.4 ± 1.7 and 2.1 ± 1.8 days, respectively in groups 1 and 2 (Table 1). No significant differences were detected in terms of mean patient age, mean tumor size, intraoperative blood loss, and duration of hospital stay between the 2 groups (Table 1).

In group 1, renal vein injury occurred in 4 patients during renal pedicle dissection. Bleeding due to renal vein injury was controlled laparoscopically in 3 patients. Fourth patient was converted to open surgery and the injury was repaired. In group 2, drop of postoperative serum hemoglobin was detected in 1 patient. Abdominal ultrasound revealed hematoma in the nephrectomy region. Blood transfusion was performed in addition to conservative treatment and the patient was stabilized and did not require open conversion.

Mean operation time was 64.9 ± 19.3 and 28.2 ± 7.7 minutes, respectively in groups 1 and 2, respectively ($P = 0.001$) (Table 1). Comparison of the operation time between the 2 groups and related subgroups (right and left nephrectomy procedures, radical and LSNs) and parameters (vascular stapler or endoclips used for vascular control of the kidney) involving patients who underwent transperitoneal laparoscopic nephrectomy (TLN) procedures are shown on Table 1.

In patients who underwent right TLN, vascular stapler for hilar control was used in 54% (n = 22) and 85% (n = 40) of the patients in groups 1 and 2, respectively ($P = 0.0001$), whereas endoclips for hilar control was used in 46% (n = 19) and 15% (n = 7) of the patients in groups 1 and 2, respectively ($P = 0.0001$) (Table 1).

In patients who underwent left TLN, vascular stapler for hilar control was used in 36% (n = 16) and 86% (n = 44) of the patients in groups 1 and 2, respectively ($P = 0.0001$), whereas endoclips for hilar control was used in 64% (n = 28) and 14% (n = 7) of the patients in groups 1 and 2, respectively ($P = 0.0001$) (Table 1).

Description of our modified technique is shown on Figure. 1.

DISCUSSION

Laparoscopic RN for RCC and LNU for transitional cell carcinoma are increasingly being performed as effective methods of extirpative surgery having the advantages of being minimally invasive surgeries without deteriorating the

TABLE 1. Comparison of the Patient Groups Who Underwent Transperitoneal Laparoscopic Nephrectomies by Using the Standard and the Modified Techniques

	Standard Technique (Group 1)	Modified Technique (Group 2)	*P*
No. patients	85	98	
Patient age (y)	49.6 ± 4.2 (range, 34-72)	50.3 ± 3.7 (range, 33-69)	$P > 0.05$
Mean tumor size (cm)	7.2 ± 1.7 (range, 3-11)	6.8 ± 1.8 (range, 3.4-10.6)	$P > 0.05$
Intraoperative blood loss (mL)	150 ± 30 (range, 40-240)	40 ± 10 (range, 30-100)	$P > 0.05$
Duration of hospital stay (d)	2.4 ± 1.7 (range, 1-4)	2.1 ± 1.8 (range, 1-3)	$P > 0.05$
Operation time (min)	64.9 ± 19.3 (n = 85)	28.2 ± 7.7 (n = 98)	$P = 0.001$
Right nephrectomies (min) (overall, n = 88)	68.7 ± 23.4 (n = 41, 47%)	24.2 ± 6.3 (n = 47, 53%)	$P = 0.001$
No. patients with vascular stapler used for hilar control	(n, %) n = 22, 54%	(n, %) n = 40, 85%	
No. patients with endoclips used for hilar control	(n, %) n = 19, 46%	(n, %) n = 7, 15%	
a. Radical (min)	73.2 ± 18.1	23.6 ± 5.7	$P = 0.001$
b. Simple (min)	62.7 ± 23.3	26.2 ± 6.1	$P = 0.001$
Left nephrectomies (min) (overall, n = 95)	63.8 ± 17.1 (n = 46, 46%)	33.6 ± 5.1 (n = 54, 54%)	$P = 0.001$
No. patients with vascular stapler used for hilar control	(n, %) n = 16, 36%	(n, %) n = 44, 86%	
No. patients with endoclips used for hilar control	(n, %) n = 28, 64%	(n, %) n = 7, 14%	
a. Radical (min)	65.6 ± 19.2	32.8 ± 4.1	$P = 0.001$
b. Simple (min)	67.3 ± 16.5	33.7 ± 6.2	$P = 0.001$

oncologic outcomes.[15] Lower intraoperative blood loss, decreased postoperative analgesic requirement, and quicker convalescence are the advantages of laparoscopic surgery.[16] Although longer operative times and higher costs have been suggested as the only drawbacks of laparoscopic approach, they seem to be approaching those of open surgery due to increased experience, improved instrumentation, and modification of the surgical technique.[16]

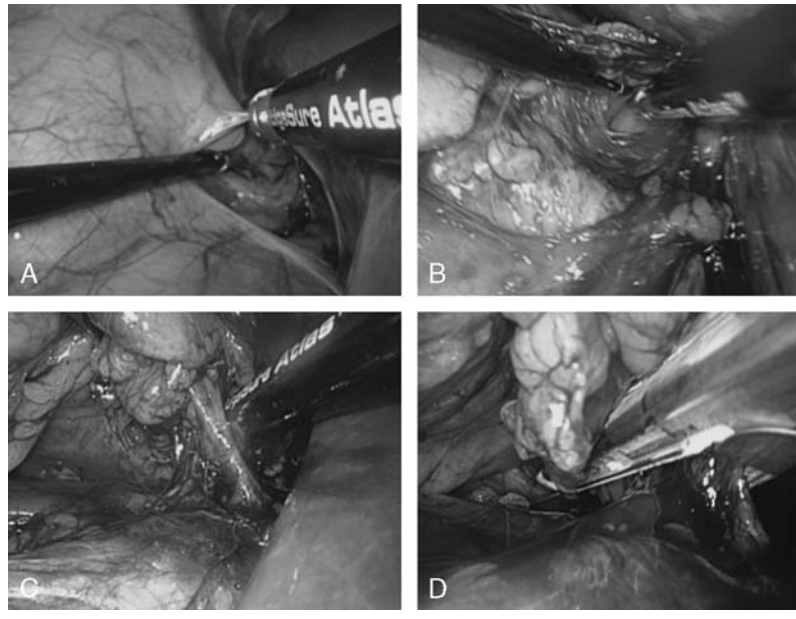

FIGURE 1. Demonstration of modified technique (right transperitoneal radical nephrectomy). A, Incision of the peritoneum at the superior pole of the right kidney. B, Entrance into the Morison space (hepatorenal recess or subhepatic recess that separates the liver from the right kidney. C, Dissection of the renal pedicle (renal artery and vein). D, En bloc ligation of the renal pedicle with a vascular stapler. Thereafter, lower pole of the kidney is dissected, ureter is ligated with an endoclip and cut.

Certainly, a learning curve exists for performing laparoscopic nephrectomy. Jeon et al[17] suggested that 15 cases are needed for a novice surgeon to achieve competence in LRN. In our study, the laparoscopic surgeon (L.T.) who performed the procedures in our study felt confident after initially successfully performing 10 cases in each group. However, the number of procedures needed to complete the learning curve might be different from one surgeon to another, which is not exactly certain in the current literature. Although we modified our technique in group 2, there is no doubt that patients in group 2 were operated after a certain amount of upper urinary tract laparoscopic urologic experience gained after group 1, which we think might have an impact on the results particularly the operation time. Surgeons' experience might be suboptimal during operating patients in group 1 when compared with group 2.

In our study, group 1 involved the classical technique. Dissection of the ureter is one of the initial steps of this technique that is performed after mobilization of the colon particularly in left TLN. Identification of the ureter in the retroperitoneal fat particularly in overweight and obese patients might be time consuming and difficult in some cases.[8] In this occasion, some maneuvers such as identification of the gonadal vessels coursing anterior and parallel to the midureter, gently stroking the retroperitoneal fat in a horizontal manner with an atraumatic grasper and searching for ureteral peristalsis and lastly looking for ureter where it crosses the common iliac vessels are suggested. However, in our modified technique this step is avoided at the beginning of the procedure. Besides, this step might further add complications such as tearing of gonadal vessel from renal vein or vena cava, injury of the iliac vessels, and increased operation thus anesthesia time. Instead, upper kidney pole is exposed initially after mobilization of the colon. Regarding the right laparoscopic nephrectomy procedures, the Morison space is entered (hepatorenal recess or subhepatic recess), which is the space that separates the liver from the right kidney.[18] Although this space is not filled with fluid under normal circumstances, fluid can collect in this space when the abdomen fills with fluid. Identification of this space significantly facilitates the right laparoscopic nephrectomies because entering this space easily detaches the right kidney upper pole from the surrounding structures. Therefore, our modified technique is useful particularly in right TLN procedures. However, in the classical technique, when the ureter is found out initially and elevated laterally by traction, the upper pole of the kidney inclines toward the closely located vena cava inferior on the right side which might cause risk of vena cava inferior injury during laparoscopic dissection of the upper kidney pole. This risk is avoided in our modified technique.

Recently, Porpiglia et al[12–14] described their experience with direct access to renal artery during performing transperitoneal right RN procedures. Although they did not find any significant difference between the groups of patients that used standard technique versus their modified technique with direct access to renal artery in terms of mean blood loss, operative time, and hospital stay. They concluded that early ligature using direct access to the renal artery at the Treitz ligament permits the surgeon to follow the classic steps and principles of RN.[12–14] In our study, we performed early ligature using direct access to the renal pedicle in both right and left TLN procedures. Advantages of direct access and early ligature of renal pedicle can be summarized as: (a) following the classic steps and principles of performing RN as in open surgery; (b) lack of manipulation of the renal mass; (c) lower risk of bleeding during further steps of dissection (particularly in the presence of peritumoral vessels); and (d) decreasing the risk of malignant cell spread due to avoiding manipulation of the kidney before ligating renal artery.[12–14] Disadvantages of this technique might be its difficulty in the presence of hilar and para-aortic metastatic lymph nodes or hilar large renal mass. It is important to remember that our modified technique should be carefully applied to the left kidneys where lumbar vein may be found in 20% of all cases. In those cases, the routine approach "from below" along the gonadal vein will allow a good visualization of the posterior wall of the renal vein and early identification of the lumbar vein sparing unnecessary injury. Although lack of manipulation of the renal mass seems to be one of the advantages of direct upper pole access, this may be true particularly for lower pole tumors but not for the tumors located in the other parts of kidney including upper pole and anterior part. The classic technique might be more feasible for the surgical management of upper pole tumors that warrants further research.

Operation time was significantly shorter in patients who underwent TLN by using the modified technique both in right and left-sided cases (Table 1). In addition, operation time was significantly shorter in patients who underwent LRN or LSN in the modified technique groups compared with the standard ones both in right and left-sided cases (Table 1). In both right and left TLN procedures, vascular stapler for renal hilar control was used in significantly higher percent of patients in the modified technique groups compared with the standard ones (Table 1) that might have shortened the operation time.

In our series, we used en bloc ligation of the renal pedicle with a vascular stapler in 38 patients (45%) in group 1 and 84 patients (86%) in group 2. Certainly, en block ligation of the renal hilum might have an impact on the decreased operating time and that probably also explain the less blood loss in group 2. Schatloff et al[19] reported that mean operative time and mean operative blood loss did not differ for groups who underwent en bloc stapling versus individual stapling of the renal hilum during laparoscopic nephrectomy and LNU procedures. In contrast, Conradie et al[20] reported that using the en bloc ligation of the renal pedicle with a vascular stapler for laparoscopic nephrectomy has been favorable in terms of operating time. Kouba et al[21] suggested that the blood loss and open conversion rate trended lower in the en bloc hilar ligation with the stapler group compared with individual hilar vessel ligation in their series. A retrospective chart review of 433 consecutive patients who underwent LSN, LRN, and LNU by Rapp et al,[22] the overall incidence of en bloc ligation of the renal pedicle was reported as 6.0%. The reasons for en bloc ligation were summarized as difficult hilar dissection and/or the appearance of the renal hilum and urgent ligation secondary to bleeding.[22] No immediate or short-term complications related to this method of hilar division were reported.[22] In our series, we used vascular stapler for en bloc pedicle ligation mainly due to the surgeon's preference in addition to the above mentioned reasons. Currently, no evidence seems to exist in terms of arteriovenous fistula development in human nephrectomies after ligating the hilum en bloc with titanium staplers.[21]

Similarly, others also reported no instances of arteriovenous fistula cases in their series with the use of vascular staplers for ligating the renal hilum.[19–24]

It is difficult to assess the exact gain of the new access because we have not documented the exact time spent on each separate surgical step, which is one of the limitations of our study. Lastly, to perform the surgery fast does not mean performing it better. However, technical modifications as in our experience seems to facilitate TLN procedures without increasing the complication risk that would certainly save operating theatre time and cost.

CONCLUSIONS

We recommend direct access and early ligation of renal pedicle during performing TLNs permitting a faster access to the renal pedicle and replicating the principles of open RN that seems to significantly facilitate these procedures compared with the standard technique particularly in terms of operation time. In addition, en bloc hilar ligation of the renal pedicle with a vascular stapler seems to be safe and does not seem to be adding any morbidity.

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