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Robotic–assisted partial nephrectomy without using ureteral stent: a single center experience

Üreteral stent kullanılmadan gerçekleştirilen robotik yardımlı parsiyel nefrektomi: Türkiye'den tek merkez deneyimi

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ABSTRACT

Objective: To share our results of robotic assisted partial nephrectomy (RAPN) we performed without using ureteral stent in a single center from Turkey.

Material and methods: Medical records of consecutive 45 patients (34 men and 11 women) who underwent RAPN for kidney lesions between March 2011 and December 2014 were retrieved, and evaluated. All the procedures were performed by a transperitoneal approach without using ureteral stent prior to surgery. Renal artery clamping was used in all cases and intraoperative ultrasonography was used in 2 cases.

Results: Patients undergoing RAPN had a mean tumor size of 4.42 cm (2–8) and a mean renal nephrometry score of 5.82 (4-11). The mean estimated blood loss was 250 mL (150-450 ml) and the mean operative time was 195 minutes (150-300). There was no statistical difference between the preoperative and postoperative serum creatinine levels at the first follow-up visit (0.9 vs. 0.95, p=0.087). Surgical margin positivity was not detected in any patient, and the mean surgical margin distance was calculated as 0.4 mm (0.2-10). In only 1 patient disease recurrence was detected at the 21st month of the the follow-up period, and no distant metastases was reported in our patients at a mean follow-up of 10 months (3-36 mos). Our complication rate was 11.1% and according to the Clavien system complications were as; grade 2 (3 patients), grade 3a (1 patient) and grade 3b (1 patient).

Conclusion: With appropriately selected patients and adequate surgical experience, RAPN performed without using ureteral stent is a safe and feasible method for localized renal tumors.

Keywords: Kidney cancer; partial nephrectomy; robotic- assisted partial nephrectomy; ureteral

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ÖZ

Amaç: Türkiye'den tek merkez olarak üreteral stent kullanmadan gerçekleştirdiğimiz robot yardımlı parsiyel nefrektomi sonuçlarımızı paylaşmak.

Gereç ve yöntemler: Mart 2011 ve Aralık 2014 tarihleri arasında böbrek kitlesi nedeniyle robot yardımlı parsiyel nefrektomi yapılan 45 ardışık hastanın (34 erkek, 11 kadın) medikal kayıtları çıkarılmış ve değerlendirilmiştir. Bütün işlemler, öncesinde üreteral stent kullanılmadan ve transperitoneal yoldan gerçekleştirildi. Bütün olgularda renal arter klemplendi ve 2 olguda intraoperatif ultrasonografi kullanıldı.

Bulgular: Robotik yardımlı parsiyel nefrektomi yapılan hastaların ortalama tümör boyutu 4,42 cm (2-8) ve ortalama RENAL nefrometri skorları 5,82 (4-11) olarak hesaplandı. Ortalama kan kaybı 250 mL (150-450) ve ortalama operasyon süresi 195 dakika (150-300) olarak ölçüldü. İlk izlem süresi sonunda preoperatif ve postoperatif serum kreatinin seviyeleri arasında istatiksel anlamlı farklılık saptanmadı (0,9'a karşı 0,95, p=0,087). Hiçbir hastamızda cerrahi sınır pozitifliği saptanmadı ve tümörün cerrahi sınıra uzaklığı ortalama 0,4 mm (0,2-10) olarak ölçüldü. Sadece 1 hastamızda postoperatif 21. ayda aynı böbrekte farklı lokalizasyonda yeni kitle saptanmış olup, hiçbir hastamızda ortalama 10 aylık takiplerde (3-36 ay) uzak metastaz saptanmamıştır. Komplikasyon oranımız %11,1 olup, Clavien sınıflamasına göre dağılım; 3 hastada grade 2, 1 hasta da grade 3a ve 1 hastada grade 3b şeklindedir.

Sonuç: Uygun seçilmiş hastalarda, yeterli cerrahi deneyimle birlikte üreteral stent kullanılmadan yapılan robotik yardımlı parsiyel nefrektomi, lokalize böbrek tümörleri için güvenli ve uygun bir tedavi metodudur.

Anahtar kelimeler: Böbrek tümörü; parsiyel nefrektomi; robotik yardımlı parsiyel nefrektomi; üretral stentler

Introduction

Continuously increased use of computed tomography (CT) and magnetic resonance imaging (MRI) has facilitated identification of small renal mass lesions and resulted in increased application of partial nephrectomy (PN) for such masses.[1] Today, in indicated cases, PN has become the golden standard in the treatment of local kidney tumors (≤ p T1b).[2]

Despite the risk of increase in warm ischemia time, the ability to clamp renal artery or arteries during the operation and selective arterial clamping have enabled application of this method in cases with masses that are even larger, more complicated and display deeper parenchymal invasions.[3] Increase in PN experience that provided perfect oncologic results and reduced mortality has resulted in greater preference for the partial nephrectomy method compared to radical nephrectomy. Prevention of renal disorders and better survival rates are among other advantages of PN.[4] With developments in minimally invasive surgical techniques, PN has been started to be performed with laparoscopic methods, but the technical difficulties associated with laparoscopic PN (LPN), long learning curve, necessity of higher skills for suturing and reconstruction, working in a 2-dimensional environment, and ergonomic issues have been considered to be the main problems.[5] Consequently, LPN is a technically difficult method that requires advanced skills with respect to intracorporeal suturing and renal reconstruction.[6]

Wider use of robotic systems over the recent years and its adaptation to all types of urological operations have brought along the transition from laparoscopic to robotic methods in PN as well. Robotic assistance helps the surgeon handle the technical difficulties associated with LPN. The mobility, enlarged 3-dimensional vision, prevention of tremor, and ergonomics provided with articulation of robotic tools facilitate tumor excision and renal reconstruction with lower warm ischemia times and complication rates.[6] Herein, our aim is to share the results of our experience with robotic-assisted PNs (RAPN) performed without using ureteral stent in a single center from Turkey.

Material and methods

Between March 2011 and December 2014, 45 patients (34 males, 11 females) who underwent RAPN were included in this retrospective study after written permissions obtained from the ethics committee of our hospital (permission protocol number: 44-2015). Since the method used based on the characteristics of the mass lesions and the patients' preferences, no randomization took place. Prior to the procedure, all patients underwent contrast-CT or MRI along with renal imaging, and a 3-dimen-sional reconstruction when necessary. Written approval form was obtained from each patient before operation. Demographic characteristics of the patients, pre- and postoperative findings, and operation details were recorded. The same team performed all of the procedures using the Da Vinci Si (Intuitive Surgical, Sunnyvale, CA, USA) surgical system.

Operation technique

The patient was first fixated on the table in modified or full flank position. Afterwards, a pneumoperitonium of 15 mmHg was established using a Veress needle. Hasson technique was preferred in cases with a history of open surgery. None of our patients had a ureteral catheter placed in the renal unit to be intervened prior to the operation. Three arms of the robot, and in case of need the fourth arm were used. All procedures were performed via transperitoneal route. The robot was brought closer with a 20° angle from the back and cranial region of the patient and was docked to the ports. Generally a camera was used with a 0° lens, and in case of need with a 30° lens. As robotic instruments bipolar Maryland forceps, monopolar cautery scissors, and needle driver were used. Intravenous mannitol infusion (12.5 g) was initiated approximately 10 minutes before the placement of a vascular clamp. The mass was excised and placed in a safe region within the abdomen. Robotic scissors were replaced with robotic needle driver and ProGrasp forceps were prepared for sliding-clip renorrhaphy in a non-dominating manner, as described by Benway et al.[7]. Open collecting system or major vascular openings were closed with absorbable 2/0 or 3/0 Vicryl sutures.Following completion of renorrhaphy, bulldog clamp was opened and the defect was checked for bleeding. Undocking was performed following a final control of the region and the ports were removed. The mass in an organ bag was removed most of the time through the assistant port or enlarged camera port in case of need.

Results

Robotic-assisted PNs were performed in 45 renal units of 45 patients (34 males, 11 females) at our clinic. The mean age of the patients was 56 (36-79) years. The renal mass was on the left side in 29 and on the right side in 16 patients. The masses were in the upper pole (n=21), lower pole (n=19) or the mid pole (n=4) of the kidney. The mean tumor size was 4.42 (2-8) cm. The mass size was over 4 cm in 15 patients (>4 cm ≤7 cm in 13 and 8 cm in 2 patients). In these 15 patients, the mass was exophytic and had polar localization, and the pathological diagnosis was renal cell carcinoma (RCC). Two of our patients had masses in solitary kidneys with mass sizes of 3 and 4 cm respectively. Two patients had endophytic masses while 2 patients had a mass between the lower pole and the renal sinus. The demographic characteristics of the patients are displayed in Table 1.

Özkan et al.
Robotic–assisted partial nephrectomy without using ureteral stent: a single center experience

3

Table 1. Demographic data of the patients

Patients, (n)	45
Age (years)	56 (36-79)
Gender	
Male, (n)	34
Female, (n)	11
Laterality	
Left	29
Right	16
Localization	
Upper pole	22
Lower pole	19
Mid pole	4
Preoperative serum creatinine level	0.9 mg/dL (0.7-1.3)
Tumor size	4.42 cm (2-8)
Renal Nephrometry Score	5.82 (4-11)

Table 2. Operative and histopathological data of the patients

Amount of bleeding	250 mL (150-450)
Operative time	195 minutes (150-450)
Time to hospital discharge	3.64 days (3-6)
Warm ischemia time	20 minutes (14-30)
Histopathological types	
RCC	41
Oncocytoma	2
Angiomyolipoma	2
Stage	
T1a	26
T1b	13
T2a	2
Fuhrmann grade	
Grade 1	15
Grade 2	20
Grade 3	6

RCC: renal cell carcinoma

The mean duration of surgery was 195 (150-300 mins) minutes and warm ischemia time measured between tumor resection and renal reconstruction was 20 (14-30) minutes. A mean volume of 250 (150-450) mL of blood was collected in the aspirator during the operation. None of the patients received intraoperative or postoperative blood transfusions. All procedures were completed robotically and no transition to open surgery or radical nephrectomy was needed. Intraoperative ultrasonography was used in two patients who had endophytic masses, where the ultrasound probe was directed through the 12 mm assistant port. The surgical margins were negative in these two patients. Results of the histopathological evaluation of 45 removed masses were reported as angiomyolipoma in 2, oncocytoma in 2, and RCC in 41 patients. Cellular types detected in RCC patients were clear cell (n=21), chromophobe (n=13), and papillary (n=7) carcinoma which were classified as grade 1 (n=15), grade 2 (n=20), and grade 3 (n=6) according to Fuhrmann grading system. The mean preoperative renal nephrometry score of the masses, as described by Kulikov and Uzzo[8] was 5.82 (4-11) points. The pathologic stages were T1a in 26, T1b in 13, and T2a in 2 patients with RCC and none of them had surgical margin positivity. The distance of the tumors from the surgical margin was 0.4 mm on average (range: 0.2-1 cm). The operative and histopathological data of our patients are presented in Table 2. In five patients (11.1%) the following complications were observed: Three patients who were discharged with conservative therapy had bleeding related to the generalized subcutaneous ecchymosis at the location of the port where draining tube was placed. One patient had incisional hernia at port location; and approximately 5 cm pseudoaneursym developed in the operated kidney of another patient who underwent percutaneous selective angioembolization. The complications we observed were of grade 2 (n=3), grade 3a (n=1), and grade 3b (n=1) according to Clavien classification.[9] The mean preoperative serum creatinine level of our patients was 0.9 (0.7-1.3) mg/dL, while it was 0.95 (0.8-1.4) mg/dL at the postoperative 3-month follow-up visit (p=0.087, *chi*-square). With a mean duration of 10 (3-36) months of follow-up, we did not detect port site or distant metastasis in any of our patients. In a patient who had a 2.5 cm tumor (clear cell RCC, Fuhrmann grade 2) localized in the lower pole of the left kidney, a new tumoral focus of 1 cm was detected in the mid-upper localization of the same kidney at postoperative 21st month Upon the patient's approval, an open partial nephrectomy was performed. This patient is still on follow-up without complications. We had a disease-free survival rate of 100 percent.

Discussion

A transition has been in place from radical nephrectomy to open PN, then to LPN, and finally to RAPN in the management of cases with small renal masses.[10] Compared to open PN, LPN is more advantageous in terms of postoperative pain, duration of hospital stay, return to daily activities, and bleeding.[11,12] These advantages of LPN are valid also for RAPN and all 3 methods have similar oncologic results. On the other hand, it is apparent that the most significant predictor in an optimal nephron sparing surgery is warm ischemia time.[6] While the average warm

ischemia time is 20 minutes in open PN, it can reach 30 minutes in LNP and the procedure can be performed with cold ischemia in open PN.[6] While there are many studies comparing LPN and RAPN today, there are unfortunately no randomized studies that compare open PN with RAPN. Choi et al.[13] compared 2240 patients who had LPN and RAPN, and reported no significant difference between the two groups with respect to complications, changes in serum creatinine levels, duration of operation, bleeding, and surgical margin positivity. In the same study the authors also reported a lower rate of transition to open surgery and radical nephrectomy, shorter warm ischemia time, shorter hospital stays, and lesser changes in glomerular filtration rates in the RAPN group.[13] In RAPN series by Scoll et al.[14] performed on 100 patients, the average size of the excised tumors (2.8 cm), ischemia time (25.5 min), surgical margin positivity rate (5.7%), transition rate to open surgery (2%), major (6%) and minor (5%) complication rates were reported as indicated. A retrospective study by Long et al.[15] which compared cases with 199 RAPN and 182 LPN did not detect a significant difference across the perioperative parameters but reported a lower rate of transition (1% vs. 11.5% for LPN) to open surgery, and a smaller decrease (12.6% vs. 16%) in the glomerular filtration rate in the RAPN group Abourmarzouk et al.[16] conducted a comparative study with 717 patients (313 RAPN vs. 404 LPN) and discovered a shorter warm ischemia time in the RAPN group but did not detect a significant difference with respect to other parameters. While the complication rates were comparable across LPN and RAPN, the reported complication rate for masses larger than 4 cm was 26.7% in the RAPN group. [17] In Kaouk et al.'s[18] study with 400 RAPN cases, the intra- and post-operative complication rates were 2.7% (11 patients), and 15.3% (61 patients), respectively. The complications were grade 3 and 4 in 3.2% of the cases respectively. Kural et al.[19] performed a study on patients who had undergone LPN (n=20), and RAPN (n=11) and reported that warm ischemia time was significantly lower in the RAPN group (27.3 minutes vs. 35.8 minutes). In the same study, the authors also reported that the mean duration of operation was 185 (120-170) minutes and the amount of bleeding was 286 ml for RAPN.[19] In general, it is observed that RAPN is more advantageous compared to LPN with respect to warm ischemia time. Warm ischemia time is important for reserving renal functions and Mir et al.[3] reported that the preoperative renal functions and parenchymal volume preservation are important for ultimate function after PN. Warm ischemia time is observed to be correlated with residual functional parenchyma, which is also a significant indicator for postoperative renal functions.[3] Warm ischemia times over 25 minutes are not recommended, and cold ischemia is advised if the procedure is prolonged.[4] Boylu et al.[20] reported that preoperative renal nephrometry score can also be used to predict the warm ischemia time in RAPN. According to this group, high scores are related with longer warm ischemia times.[20]

In our series of 45 patients, the patients' age, gender, sizes of renal masses, renal nephrometry scores, and pathologic characteristics were generally in accordance with the medical literature. Although RAPN was preferred more among patients with small renal masses (≤4 cm), we have performed RAPN on masses greater than 4 cm in our 15 (T1a and T2) patients. We believe that the LPN experience of the team played a role in this. Brandao et al.[21] reported their experiences on RAPN in 29 patients with renal masses of ≥7 cm in diameter and in comparison with tumors smaller than 4 cm, they reported significant differences with respect to median operative (200 vs. 180 minutes), and warm ischemia times (26.5 vs. 19 minutes), and amount of bleeding (250 mL vs. 150 mL). This group reported that RAPN is a safe method for masses over 7 cm if the mass is exophytic, and benign with a polar localization.[20] In our study warm ischemia time which was the most significant predictive factor in PN was around 20 minutes in accordance with the medical literature (≤25 mins). [3,5,10,14,19] Lack of any significant difference between the pre-and postoperative serum creatinine levels of our patients can be evaluated as an indicator of the appropriateness of the procedure we performed in terms of warm ischemia times. Again, the mean surgical margin distance of 0.4 mm (0.2-1 cm) detected among our patients who had RCC can be considered a safe distance oncologically. Additionally a new metastatic focus was observed in a different localization of the kidney in only one of our patients. The most important feature of our series, which may also be criticized, is that none of our patients had a ureteral catheter placement prior to the procedure. None of our patients had intraoperative problems or postoperative urine extravasations associated with refraining from catheterization. Zargar et al.[22] reported that routine ureteral catheterization is not necessary in minimally invasive PN (LPN and RAPN) but it is necessary in cases where the mass is close to the collecting system or when novice surgeons are performing the procedure. They reported that routine ureteral catheterization did not provide any benefits in blocking urine extravasation.[22] Tomaszewski et al.[23] also concluded that renal pelvic anatomy which is measured by renal pelvic score can also predict urine extravasation after open and robotic partial nephrectomy. Based on the renal pelvic scoring system, preoperative identification of the patients with increased risk for urine leak should be considered in perioperative management. Current developments in imaging techniques, and 3-dimensional configuration techniques, and the ability to clearly identify the relationship between the mass and the collecting system help us in decision making on this process. Our findings with respect to operative times (195 mins), and amounts of bleeding (and 250 mL) were generally in line with the findings in the medical literature.[1,11,18,19] We believe that our patients did not require blood transfusion because of effective and easy closure of the ports with the suture advantages of RAPN. Generalized subcutaneous ecchymosis that was observed in three of our patients in the postoperative period originated from

Özkan et al.
Robotic-assisted partial nephrectomy without using ureteral stent: a single center experience

5

the nearly lateral ports. We believe that the three muscle layers on the location of more lateral ports, different than the midline musculature, and the associated increased vascularity increased the bleeding risk of the ports. Therefore, all port regions should be carefully sutured following trocar removal. Considering the complications, three patients who had port bleeding were classified as Clavien grade 2, and treated with topical application of heparinoid preparations, and alcohol dressing. A patient who developed a 5 cm- pseudoaneurysm was treated with selective embolization without anesthesia under radiological guidance (grade 3a). Another patient needed an incisional hernia repair (grade 3b) under general anesthesia. Based on these findings in our study minor , and major complication rates were 6.66% (3 patients), and 4.44% (2 patients), respectively. which were again in accordance with the medical literature.[16-19] Omae et al.[24] also reported that early stage renal artery pseudoaneurysm was observed at a high rate (21.7%) after a minimally-invasive PN (LPN and RAPN) procedures. This group recommends avoiding deep excisions in renal sinus in order to prevent renal artery pseudoaneurysm.[23] The relatively low number of patients in our series is due to the high cost of robotic systems in Turkey in consideration of economic conditions in the country and the purchase of the tools in USD currency.

Mano et al.[25] compared open PN with RAPN and reported a $3,091.00 difference between the cost-effectiveness of two methods. Laydner et al.[26] also compared a total of 325 open PN, LPN, and RAPN procedures and reported that the operation room costs were higher for RAPN while the anesthesia and hospital costs were higher in open PN. They reported an approximate difference of $632.00 between the costs incurred by LPN and RAPN.

Inevitably, laparoscopic experience of the assistants, their assistance in clip administrations, aspiration, and surgical area cleaning, and their ability to effectively manage the process by the bedside during RAPN also play a significant role in the success of the surgery. The experience of the team in laparoscopy, in our opinion, enables administration of RAPN in even difficult cases with larger, endophytic or hilar tumors and obviates the need of routine ureteral stent use.

In conclusion, the goal of PN is to completely remove the tumor, provide sufficient bleeding control, perform renal reconstruction without prolonging warm ischemia time. Da Vinci robotic system enables realization of all of these goals in an almost ideal way with its design, stereoscopic view it provides, and use of tools with articulation. We believe that it allows more surgeons to perform a complex procedure like PN with minimal invasion with its faster learning curve compared to conventional laparoscopy, its capacity to reduce warm ischemia time, its lower overall complication rates with outcomes comparable to LPN with respect to other parameters. According to us placing a ureteral stent routinely prior to operation is unneccesary because LPN experience and the benefits of the robot such as the enlarged 3-dimensional vision which allows for a clearer and easier detection of the openings in the collecting system and the ability to close the openings more effectively with the easier suturing process. Ureteral catheter placement prior to the procedure becomes a factor that prolongs the duration of anesthesia considering the repositioning of the patient afterwards. Still, we believe that ureteral catheter placement is necessary in cases with masses that are assumed to invade the collecting system or very close to it.

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