Research article

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Results and initial experience of robot - assisted radical nephrectomy at Binh Dan Hospital

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Abstract

Introduction: To evaluate and analyze the initial experience of robot-assisted radical nephrectomy (RARN) at Binh Dan Hospital.

Patients and methods: We retrospectively analyzed data from 46 patients diagnosed with renal tumors who underwent RARN at Binh Dan Hospital from January 2020 to September 2023. Clinical characteristics, surgical procedures, and complications were recorded and analyzed.

Results: 46 patients (29 males, 17 females, median age 58 years, range 48 to 66) were treated. The median tumor diameter was 68 mm, and 24, 19 and 3 patients were classified into cT1, cT2 and cT3, respectively. No patients required conversion to open surgery, and the median operative time and docking time were 158 and 14 minutes, respectively. The median estimated blood loss was 46ml, and no patient required blood transfusion. During the perioperative period, no major complications corresponding to Clavien-Dindo grade ≥3 occurred. Pathological results identified 41 cases of renal cell carcinoma (RCC) and 5 cases of non-RCC.

Conclusion: Based on this study, we preliminarily conclude that RARN is a safe and effective method. The perioperative outcomes from initial experiences are promising. Overall, the study helps reinforce the evidence, aiming to position RARN as a promising alternative solution to conventional laparoscopic surgery in cases of complex renal tumors.

Keywords: Robot-assisted radical nephrectomy, renal tumor.

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1. INTRODUCTION

Radical nephrectomy remains the standard treatment for patients with complex renal tumors, where partial nephrectomy is not feasible (1). Recent evidence suggests that although there is no significant difference in oncological outcomes between open radical nephrectomy and laparoscopic surgery, laparoscopy has demonstrated several advantages over open surgery in terms of perioperative outcomes, including reduced blood loss, lower complication rates, shorter length of hospital stay, and better postoperative pain management (2). Therefore, laparoscopic radical nephrectomy is now considered the gold standard for patients with localized RCC who are not candidates for partial nephrectomy.

In recent years, robotic surgery has rapidly evolved and been embraced for a variety of surgeries due to its distinct advantages, such as providing clear, sharp three-dimensional (3D) vision, enabling precise and delicate maneuvers, minimizing natural body tremors caused by surgeons, and facilitating easy grasp and manipulation within a wide range of motion (3). In the field of kidney surgery, partial nephrectomy with robot assistance has significantly increased and is considered the standard treatment for T1-

stage localized tumors (4-6). Furthermore, since the initial report by Klinger and colleagues (7), RARN has emerged as a promising alternative to open or laparoscopic surgery. The proportion of patients with RCC undergoing RARN has significantly increased over the past decade (8-10). However, to date, there have been no randomized controlled trials comparing the results of RARN to other surgical methods, and the advantages of this approach in treating patients with localized RCC remain a topic of debate (8-15). Consequently, in the present investigation, we document our preliminary observations of RARN conducted on a cohort of 46 patients diagnosed with renal tumors, at a single medical facility, with a focus on the outcomes observed during the perioperative period.

2. PATIENTS AND METHODS

Employing an interventional study design, we included all patients with renal tumors who underwent RARN at Binh Dan Hospital from January 2020 to September 2023.

Surgical Procedure

Preoperative evaluation included clinical assessment and laboratory tests such as complete blood count, urinalysis, liver and kidney function tests, and coagulation profile. Imaging studies such as chest X-ray and ultrasound were performed to assess the nature, size, location, and stage of the tumor. CT scan or MRI, with higher accuracy, was used to evaluate lymph node involvement, vascular status (according to TNM staging). Renal scintigraphy (preoperative) was performed to assess the function of both kidneys.

* Surgical equipment:

- The Da Vinci Si robotic surgical system and associated instruments were utilized. Additionally, 1 trocar 12mm (camera) and 3 trocars 8mm (for the operative arms) were employed.

- The operating room was equipped with the Da Vinci Si robotic system, monitors, and suction machines. Endoscopic or open surgery could be performed as needed.

- A specialized urological operating table, with fixtures to secure the patient when inclined, and a hip and back lift on the opposite side.

- Instruments for both laparoscopic and open surgery.

* Bowel preparation: Bowel preparation can be done the day before using Fleet Phospho-Soda 45ml, 2 bottles taken 10-12 hours apart. Prophylactic antibiotics were administered using broad-spectrum antibiotics.

All surgeries were performed under general anesthesia. Surgery was performed through a transperitoneal approach. Nasogastric and urinary catheters were placed. The patient was positioned and trocars were inserted for the robot arms (docking). The patient was tilted to the opposite side of the surgical site at an angle of 60-90 degrees, with the hip inclined on the table, which could be bent about 15 degrees at the midpoint. Arm pads and pressure points were padded, and the patient was secured to the table with straps and cloth bands; the tilt table was checked to ensure the patient remained in a safe position if the table moved during the robot arm installation process.

Trocar placement was then established, followed by attaching the robotic arms to maximize the distance between all robotic arms. The surgery was then performed.

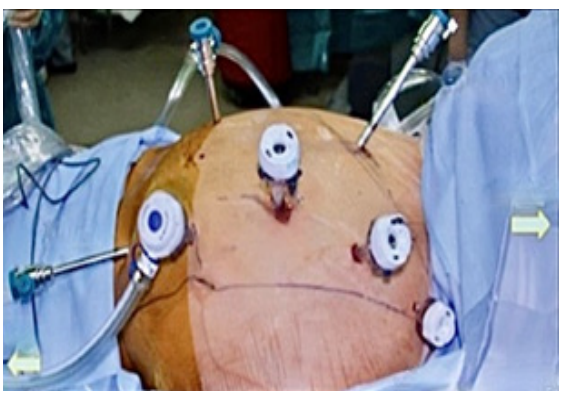

Figure 1: Trocar placement setup

Colon mobilization to the midline: Perform dissection of the Toldt's fascia to bring the right colonic flexure (hepatic flexure) or left colonic flexure (splenic flexure) to the midline to expose the surgical area and avoid damage to the colon. Dissection around the renal hilum: Dissect into the renal hilum, where the renal artery can be identified by pulsation. Alternatively, on the right side, follow the inferior vena cava, and on the left side, follow the gonadal vein or the abdominal aorta to reach the renal hilum.

Alternatively, follow the ureter; upon reaching the renal pelvis, proceed to the renal hilum.

Clamp and cut the renal artery: Clearly expose the renal artery, approximately 1 cm in length, as close to the origin as possible to avoid confusion with branches of the renal artery. Clamp with Hem-O-Lok and cut the artery. Perform similarly with the renal vein. Dissect and release the upper and lower poles and cut the ureter. Then clean the surgical area and check for bleeding. If there are lymph nodes around the renal hilum, they will be dissected after the kidney is removed.

Check the number of gauze pads. Place an abdominal drainage tube in the renal fossa. Estimate blood loss through the number of gauze pads used and the suction bottle. Remove the specimen with a specimen bag, remove the robot arms, and close the trocar incisions.

Postoperative monitoring

- Monitor fluid in the drainage tube and urine output.
- Monitor pain level, duration of pain medication use, and other symptoms.
- Check renal function, complete blood count, and biochemical indices if there are any suspicions, especially in patients with previous comorbidities.
- Perform ultrasound examination before discharge to detect postoperative abnormalities such as fluid collection around the kidney or intra-abdominal fluid.

3. RESULTS

46 cases of RARN met the study criteria.

Table 1. Patient characteristics

Age (years)	58 + 6,24 (48-66)
Gender	
Male (%)	29 (63%)
Female (%)	17 (37%)
Tumor location	
Right (%)	18 (39%)
Left (%)	28 (61%)
Tumor size	68 + 18,5 mm
Clinical stage	
T1a	6 (13,1%)
T1b	18 (39,1%)
T2a	12 (26,1%)
T2b	7 (15,2%)
T3a	2 (4,3%)
T3b	1 (2,2%)

Table 2. Intraoperative Analysis

Surgery Time	158 + 20,4 mins
Docking Time	14 + 5,2 mins
Console Time	81 + 15 mins
Blood Loss	46 + 17,5 ml
Blood Transfusion	0 cases
Main Complications	0 cases

Table 3. Postoperative Monitoring

Complications	
Postoperative fever	3 (6,5%) cases
Fluid collection	2 (4,3%) cases
Drain removal time	4,2 + 2,1 days
Hospital stay time	6,8 + 3,4 days
Postoperative pathology	
RCC	42 (91,3%) cases
Non-RCC	4 (8,7%) cases
+ AML	1 case
+ Sarcoma	1 case
+ Renal cyst	2 cases

There were five reported postoperative complications. Among these, three cases were of febrile response following surgery. The patients underwent bacterial cultures and antibiotic sensitivity testing on urine and blood specimens, followed by administration of targeted intravenous antibiotic therapy. Urine cultures turned negative within three days, and blood cultures within five days. Leukocyte counts in the blood normalized gradually. Two instances of perirenal fluid accumulation were noted, with patients reporting postoperative

lumbar and flank pain on day three. They received antimicrobial, anti-inflammatory, and analgesic treatment, resulting in clinical stabilization

4. DISCUSSION

Since Klinger and colleagues introduced robot-assisted radical nephrectomy (7), the rate of patients with renal tumors, unsuitable for partial nephrectomy, undergoing this type of surgery has been reported to increase significantly (8-10). For example, Jeong and colleagues conducted a population-based study to examine the trend of using RARN in the United States from 2003 to 2015 and found that the use of this method increased from 1.5% to 27% among all renal tumor surgeries during this period (8). Similarly, Gershman and colleagues reported that the use of RARN increased from 46% to 69% from 2010 to 2013 based on national data of 8316 patients receiving RARN or pure laparoscopic surgery for radical nephrectomy in the United States (9). However, despite such rapid proliferation, reliable data comparing robot-assisted radical nephrectomy with other surgical methods are still lacking, leading to controversy over the benefits of this method compared to others, especially laparoscopic surgery, in the treatment of renal tumors in situ.

To date, many small-scale observational studies on RARN have been conducted at a single center, and some of them have shown results in surgery equivalent to pure laparoscopic total nephrectomy, although costs have increased significantly (11,13,15). In recent years, the clinical characteristics of RARN have been further characterized by several large-scale studies (8-10,12,14). For example, Jeong and colleagues reported that RARN did not increase the risk of any major complications or postoperative complications, but it did lead to longer surgical times and higher hospital costs compared to pure laparoscopic surgery(8), while Gershman showed that compared to pure laparoscopic surgery, RARN reduced surgical complications as well as postoperative complications but had higher hospital costs and no differences in blood transfusions or length of stay(9). In this patient series, RARN could be performed without blood transfusion in all cases, with the average total operative time, docking time, and console time being only 158, 14, and 81 minutes, respectively, shorter than in previous studies(8-12), and no major surgical complications occurred. The positive results in surgery in our study may be explained by the following reasons: careful preoperative evaluation with image analysis software was performed in all cases, and the surgery was performed by experienced robotic surgeons. Regarding the surgical time of RARN, a previous study by Anele and colleagues also showed a longer duration compared to pure laparoscopic surgery, but RARN was performed in a more complex and challenging surgical context than pure laparoscopy (10). Therefore, these results suggest that if performed by experienced robotic surgeons, RARN may achieve similar or even better surgical results than pure laparoscopic surgery without increasing the risk of surgical complications.

There are some issues related to RARN that need to be discussed before applying this method at each medical center. The necessary conditions for surgeons to perform RARN include a learning curve consisting of at least 20 cases of apprenticeship, model practice, and actual practice. However, even if performed by surgeons meeting these conditions, adverse events may still occur as in the 2 cases in this patient series with blood loss of nearly 500 ml due to arteries not recognized in preoperative diagnostic imaging. In principle, RARN should be applied to complex renal tumors, unsuitable for partial nephrectomy, which cannot be simply determined by tumor size. In fact, in this study, RARN was performed in 6 cases of cT1a tumors, with careful consideration of the characteristics to avoid misuse of radical nephrectomy. Specifically, all cT1a tumors in the study series had a R.E.N.A.L score (renal tumor complexity assessment score) > 10, with 4 tumors located centrally, almost completely embedded in renal parenchyma and lying entirely between the two polar dividing lines, 1 tumor located adjacent to the renal sinus, and 1 tumor located near the collecting system of the renal pelvis.

The unique features of the robotic platform may be helpful in performing difficult surgeries (3), often performed by open surgery, such as treating tumors involving large blood vessels. In fact, there have been reports describing positive results of RARN in removing tumors involving the inferior vena cava (20,21). Furthermore, in this patient series, renal tumors with thrombi in the renal vein were successfully removed using the robot ENDOWRIST suture tool. Specifically, 2 cases of cT3a tumors with thrombi in the renal vein were isolated by Satinsky clamping, preserving over 50% of the main renal vein, which is important for preventing downstream vascular complications related to reduced flow. One case of cT3b tumor with grade II thrombus was more difficult, requiring sequential clamping of the caudal IVC, contralateral renal vein, and cephalic IVC with laparoscopic bulldog clamps. The thrombosed venous area was then opened and the thrombus removed. For such tumors, when the thrombus invades the wall of the main renal vein, the related venous segment must be excised and a negative surgical margin achieved to prevent recurrence. Therefore, when considering these results, the indication for RARN can be expanded to more complex renal tumors, including cases with renal vein thrombi extending to the inferior vena cava.

Additionally, we would like to mention some limitations of this study. Firstly, this study only included 46 patients who underwent RARN at one medical facility, and analyzed data related to surgical outcomes only. Therefore, the results of RARN at our facility need to be reassessed by increasing the sample size and extending the observation period. Secondly, RARN in this patient series was performed by a few experienced robotic surgeons; therefore, this should be taken into account when interpreting the results of this patient series. Finally, additional assessments, such as prognosis, quality of life, and hospital costs, need to be conducted to clarify the role of RARN. If possible, a randomized controlled trial comparing clinical outcomes between RARN and other surgical methods is also desired to more accurately describe the importance of this type of surgery.

5. CONCLUSION

In conclusion, this is the first report to describe the experience of RARN at a medical center. Although this study included 46 patients with localized renal tumors, including cases of difficult-to-operate renal tumors, RARN was performed within an acceptable surgical time, as well as acceptable docking and console times, without major surgical complications. Therefore, our initial experience with RARN suggests a potential important role for RARN in complex renal tumors, unsuitable for partial nephrectomy.

REFERENCES

1. Van Poppel H, Becker F, Cadeddu JA, et al. Treatment of localised renal cell carcinoma. Eur Urol. 2011;60:662-672.
2. Dunn MD, Portis AJ, Shalhav AL, et al. Laparoscopic versus open radical nephrectomy: a 9-year experience. J Urol. 2000;164:1153-1159.
3. Chen Y, Zhang S, Wu Z, et al. Review of surgical robotic systems for keyhole and endoscopic procedures: state of the art and perspectives. Front Med. 2020;14:382-403.
4. Dagenais J, Bertolo R, Garisto J, et al. Variability in partial nephrectomy outcomes: does your surgeon matter? Eur Urol. 2019;75:628-634.
5. Shin TJ, Song C, Kim CS, et al. Surgical details and renal function change after robot-assisted partial nephrectomy. Int J Urol. 2020;27:457-462.
6. Motoyama D, Sato R, Watanabe K, et al. Perioperative outcomes in patients undergoing robot-assisted partial nephrectomy: comparative assessments between complex and noncomplex renal tumors. Asian J Endosc Surg. 2021;14:379-385.
7. Klingler DW, Hemstreet GP, Balaji KC. Feasibility of robotic radical nephrectomy—initial results of single-institution pilot study. Urology. 2005;65:1086-1089.
8. Jeong IG, Khandwala YS, Kim JH, et al. Association of robotic-assisted vs laparoscopic radical nephrectomy with perioperative outcomes and health care costs, 2003 to 2015. JAMA. 2017;318:1561-1568.

9. Gershman B, Bukavina L, Chen Z, et al. The association of robot-assisted versus pure laparoscopic radical nephrectomy with perioperative outcomes and hospital costs. Eur Urol Focus. 2020;6:305-312.
10. Anele UA, Marchioni M, Yang B, et al. Robotic versus laparoscopic radical nephrectomy: a large multi-institutional analysis (ROSULA Collaborative Group). World J Urol. 2019;37:2439-2450.
11. Asimakopoulos AD, Miano R, Annino F, et al. Robotic radical nephrectomy for renal cell carcinoma: a systematic review. BMC Urol. 2014;14:75.
12. Golombos DM, Chughtai B, Trinh QD, et al. Adoption of technology and its impact on nephrectomy outcomes, a U.S. population-based analysis (2008-2012). J Endourol. 2017;31:91-99.
13. Kates M, Ball MW, Patel HD, et al. The financial impact of robotic technology for partial and radical nephrectomy. J Endourol. 2015;29:317-322.
14. Xia L, Talwar R, Taylor BL, et al. National trends and disparities of minimally invasive surgery for localized renal cancer, 2010 to 2015. Urol Oncol. 2019;37:182.e17-182.e27.
15. Li J, Peng L, Cao D, et al. Comparison of perioperative outcomes of robot-assisted vs laparoscopic radical nephrectomy: a systematic review and meta-analysis. Front Oncol. 2020;10: 551052.
16. Motoyama D, Matsushita Y, Watanabe H, et al. Significant impact of three-dimensional volumetry of perinephric fat on the console time during robot-assisted partial nephrectomy. BMC Urol. 2019;19:132.
17. Motoyama D, Matsushita Y, Watanabe H, et al. Improved perioperative outcomes by early unclamping prior to renorrhaphy compared with conventional clamping during robot-assisted partial nephrectomy: a propensity score matching analysis. J Robot Surg. 2020;14:47-53.
18. Caputo PA, Ko O, Patel R, et al. Robotic-assisted laparoscopic nephrectomy. J Surg Oncol. 2015;12:723-727.
19. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg. 2004;240: 205-213.
20. Shen D, Du S, Huang Q, et al. A modified sequential vascular control strategy in robot-assisted level III-IV inferior vena cava thrombectomy: initial series mimicking the open ‘milking’ technique principle. BJU Int. 2020;126:447-456.
21. Rose KM, Navaratnam AK, Faraj KS, et al. Comparison of open and robot assisted radical nephrectomy with level I and II inferior vena cava tumor thrombus: the Mayo Clinic experience. Urology. 2020;136:152-157.