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 2023 to May 2024. Clinical characteristics, surgical procedures, and complications were recorded and analyzed.

Results: 46 patients (29 males, 17 females, median age 58 years, range 48 to 69) were treated. The median tumor diameter was 68 mm with 24, 20 and 2 patients were classified into $cT_1N_0M_0$, $cT_2N_0M_0$ and $cT_{3a}N_0M_0$, 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.

Conclusion: Based on this study, we preliminarily conclude that RARN is a safe and effective method. The study also helps reinforce the evidence that RARN as a promising alternative solution to conventional laparoscopic surgery in cases of complex renal tumors or instances where robot-assisted partial nephrectomy is not feasible.

Keywords: Robot-assisted radical nephrectomy, renal tumor, renal cell carcinoma.

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, 11-15]. In Vietnam, due to the healthcare system not yet widely accepting RARN as a treatment option for RCC, this procedure is currently only performed at a select few facilities.

Patients and methods

Its was descriptive study. All patients with renal tumors who underwent RARN at Binh Dan Hospital from January 2023 to May 2024 were enrolled.

My research subjects are patients with kidney tumors stage $cT_{1-3}N_{0-1}M_0$. This means that patients who have been diagnosed with kidney tumors by CT scan or MRI with images (contrast enhancement of solid tumors) show malignant tumors.

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. We recorded surgical variables such as docking time, console time, total blood loss, blood transfusion, conversion to open surgery, organ damage and other major complications.

Surgical Procedure

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.

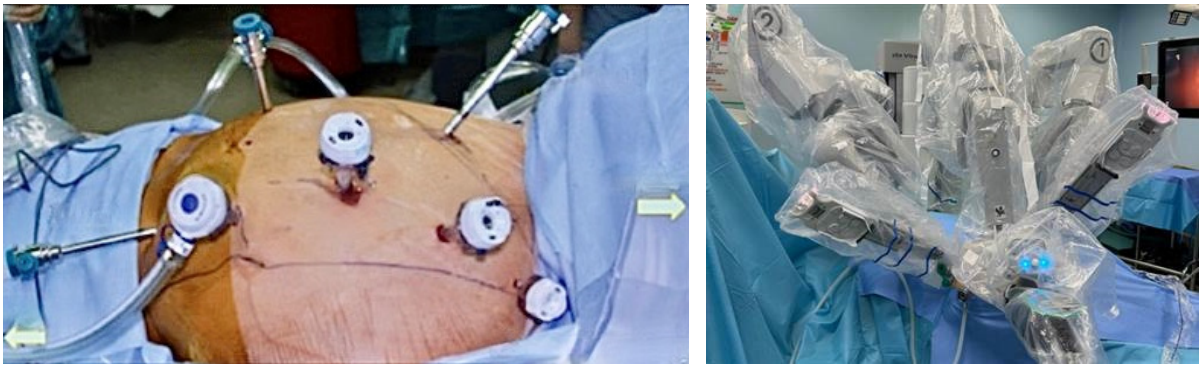

Figure 1: Trocar placement setup and docking.

Colon mobilization to the midline: Perform dissection of the Todd 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.

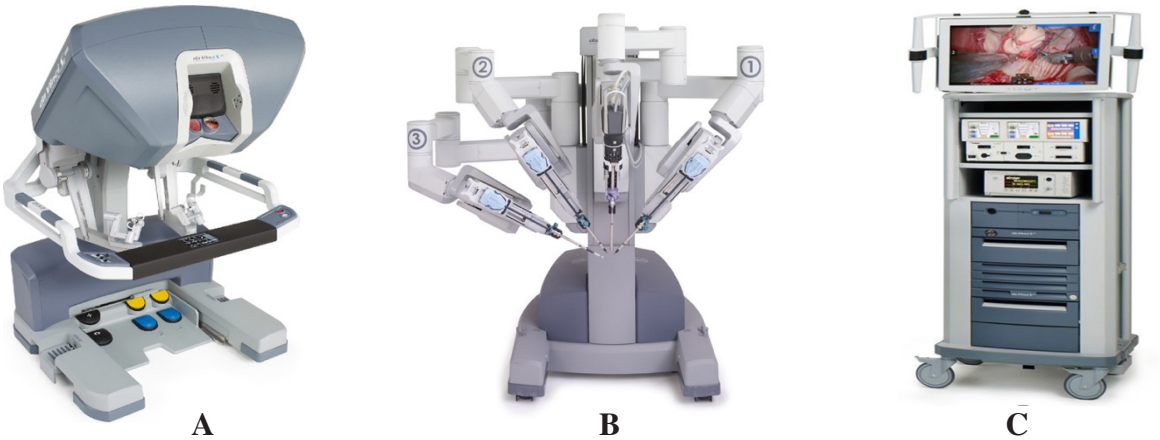

Figure 2: The da Vinci SiTM robot system includes Surgeon console (A), Patient cart (B) and Vision cart (C). Source: Jeong IG et al (2012) [8]

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.

Statistical Analysis

Clinicopathologic characteristics, surgical outcomes, surgical completeness and postoperative complications were compared in each substudy. Normally distributed continuous variables were expressed as means ± standard deviations and compared by Students t-tests, whereas non-normally distributed continu- ous variables were expressed as medians and compared by one-way analysis of variance (ANOVA). Categorical variables were expressed as numbers and percentages, and com- pared by Fishers exact test or Chi - squared test. All statistical analyses were performed using SPSS version 22.0, with p values <0.05 indicating statistical significance.

Results

46 cases of RARN met the study criterias.

Table 1. Patient characteristics

Age (years)	58 + 8,24 (min: 48 - max: 69)	
Gender	Male (%)	29 (63%)
	Female (%)	17 (37%)
Tumor size	68 + 18,5 mm (min: 38 - max: 128mm)	
Vein Tumor Thrombus	Yes	2 (4,3%)
	No	44 (95,7%)
Tumor location	Right (%)	18 (39%)
	Left (%)	28 (61%)
	Upper (%)	14 (30,4%)
	Midline (%)	17 (36,9%)
	Lower (%)	15 (32,7%)

Table 2. Intraoperative Analysis

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

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	Clear cell	33 (71,7%)
	Papillary cell	8 (17,5%)
	Chromophobe	2 (4,3%)
	Oncocytoma	3 (6,5%)
Pathological stage	pT1aN0M0	6 (13,1%)
	pT1bN0M0	18 (39,1%)
	pT2aN0M0	13 (28,3%)
	pT2bN0M0	7 (15,2%)
	pT3aN0M0	2 (4,3%)

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.

The issue of lymph node dissection in RCC according to the EAU guideline 2024 is only lymph node dissection when there are macroscopic lymph nodes visible on imaging, not routine lymph

node dissection. In our study, there were 3 cases recorded with lymphadenopathy in the renal hilum area, however the pathology results all showed inflammation of the lymph nodes.

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 [12,13]. 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 [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[10,16], and no major surgical complications occurred.

Robot-assisted surgery systems have many advantages such as: Display screen for surgeons with 3D – HD technology, clear images in real time. Articulating instruments at the wrist (Endowrist® technology) allows the use of instruments with 7 levels of movement. Improve surgical capabilities, filter hand tremors, and overcome ergonomics. Allows surgeons with no experience in standard laparoscopy to learn to immediately perform complex laparoscopic surgery.

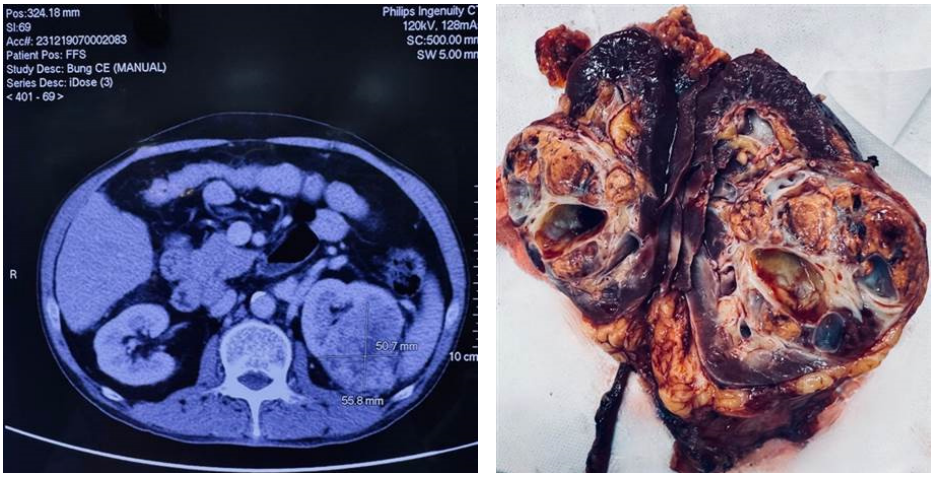

Figure 3: The kidney had a tumor 51x56mm on CT scan and when it was removed.

Source: 20th patient of our study sample.

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 [17]. 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.

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.

Conclusion

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 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 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 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.