An early experience of the robot-assisted laparoscopic nephroureterectomy without re-docking in a single position

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OBJECTIVE: *This study aims to evaluate the execution of robot-assisted laparoscopic nephroureterectomy without repositioning the patient.*
METHODS: *The clinical data of 9 patients who underwent robot-assisted laparoscopic nephroureterectomy between May 2017 and November 2018 were analyzed, proceeding in a single position, without repositioning the patient. This involved 5 men and 4 women, with an average age of 61.67 ± 10.37 years and an average body mass index (BMI) of 24.78 ± 3.84. We considered the duration of the intervention, the blood loss, the duration of the hospital stay, the duration of maintenance of the drainage and the follow-up on all patients, with or without complications and recurrence of the tumor.*
RESULTS: *The intervention was completed in all 9 cases. The average duration of the intervention was 242.89 ± 13.37 minutes, the average blood loss was 166.67 ± 70.71 ml, the average hospitalization time was 2 ± 0.71 days, the average time drainage maintenance was 5.11 ± 1.05 days and the average follow-up times without complications and tumor recurrence were 12.56 ± 6.19 months.*
CONCLUSION: *Robot-assisted laparoscopic nephroureterectomy without repositioning the patient during the procedure simplifies the procedure and shortens the duration of the procedure. It is also a safe, effective and feasible minimally invasive treatment method.*

KEY WORDS: Nephroureterectomy, Robot-assisted laparoscopic, Tumor recurrence, Single position, Upper tract urothelial carcinoma

Introduction

An upper tract urothelial carcinoma (UTUC) includes renal pelvic cancer and ureteral cancer, accounting for about 5%-10% of urothelial cancer [1-3]. At present, the gold standard of treatment is radical nephroureterectomy (RNU) and bladder cuff resection [4-6]. Nephrectomy and upper ureteral resection are usually accomplished in one step by using laparoscopy or robot-assisted laparoscopy. However, there are many surgical considerations and methods (two-step and three-step methods) in resecting the distal ureter and bladder wall.

Based on the experience of our department and other clinical medical centers, we have achieved the robot-assisted laparoscopic nephroureterectomy without re-docking in a single position. Therefore, we conducted this study to evaluate the robot-assisted laparoscopic nephroureterectomy without re-docking in a single position. The following report is about the successful implementation of the procedure in our hospital from May 2017 to November 2018.

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Materials and Methods

Patient Collection

A total of 9 patients underwent the robot-assisted laparoscopic nephroureterectomy without re-docking in a single position in the urology department of the Fifth Medical Center of the Chinese People's Liberation Army (From May 2017 to November 2018). There were 5 males and 4 females, with an average age of 61.67 + 10.37 years, an average BMI of 24.78 + 3.84, 5 cases of renal pelvic cancer, 3 cases of ureteral cancer, and 1 case of B-cell lymphoma of the ureter. 3 of the patients were physically fit and 6 patients had a prior history of concomitant disease. Detailed information is shown in Table 1. The ethics committee of our hospital approved this study and all patients had signed the informed consent.

Surgery Preparing

A urinary catheter was indwelled in all 9 patients before the operation and general anesthesia with endotracheal intubation was selected. The surgeons also ensured that an orogastric tube was in place to decompress the stomach. Operative position: Patients were placed in a modified flank position with the operation side up and propped to about 70 degrees off the bed and padded up at the waist. The ipsilateral arm was brought across the torso and supported either with pillows or preferably an elevated padded armrest. The contralateral arm was placed on the usual arm board perpendicular or slightly cranial to the operating table. The table was flexed about 10 to 15 degrees and leveled out. The surgical area was disinfected and covered with a towel.

The robot port placement design (Fig. 1, right lesion as an example) was as follows: 12mm camera port: horizontal umbilical level at the lateral rectus line on the operation side; 1st 8mm robotic port: located under the costal margin of the operation lateral rectus line, and 8cm from the camera port; 2nd 8mm robotic port: located at 8cm on the straight line with 120° angle between the 1st robotic port and the camera port; 3rd 8mm robotic port: placed between the umbilicus and the pubis and was 2cm higher than the pubis. The 12mm assistant port: located at 6cm on the midpoint vertical line between the camera port and the 1st robotic port (F1 port in Fig. 1). In patients with right lesions, an additional 5mm assistant port under the median abdominal xiphoid process was needed to assist in lifting the liver (F2 port in Fig. 1). In patients with left lesions, this assistant port was not needed (Fig. 2).

The robotic patient card was positioned vertically at 90 degrees on the back of the patient. All trocar and instruments are deployed under direct vision with a 30° upward camera. A 30° downward camera was used throughout the operation. The 1st robotic port is equipped with monopolar scissors, 2nd robotic port with Maryland bipolar, and 3rd robotic port with progripper. The 1st robotic port was equipped with needle drivers when the bladder incision was sutured.

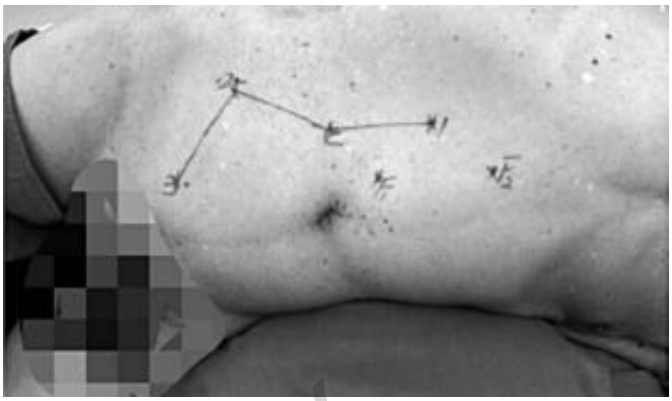

Fig. 1: Robot port placement design (right lesion).

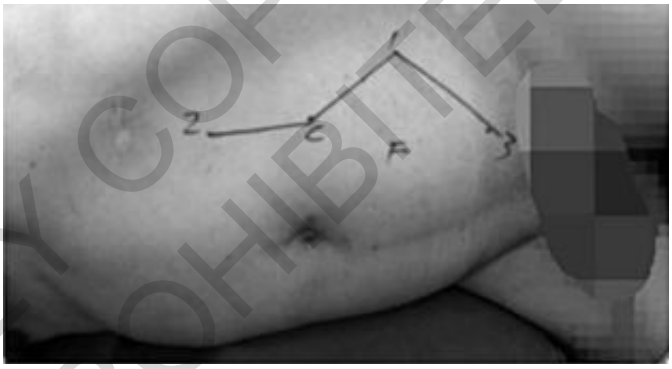

Fig. 2: Robot port placement design (left lesion).

Surgical procedure

The details of the treatment of the intramural ureter by using a bladder cuff were as follows: We explored the abdominal cavity, released adhesions, and searched for reproduction veins at the inner ring orifice. We then found the external iliac artery in the inferior abdominal cavity and performed the peritoneal incision in the sector-shaped area between the genital vein and the external iliac artery (Fig. 3). Thereafter, we found the ureter and dissected it. Hem-o-lock is often used in distal ureter to prevent the seeding of the wound with urine that contains tumor cells (Fig. 4). We dissected the ureter up to the pelvis and down to the posterolateral bladder wall and lifted the dissected upper ureter and pulled it to the cranial after which we pulled the intramural ureter and part of the bladder wall out of the bladder contour (Fig. 5). The intramural ureter and partial bladder wall were excised. In order to prevent the overflow of urine in the bladder, the method of cutting and suturing at

Fig. 3: Sectorial region of genital vein and external iliac artery.

Fig. 4: The Hem-o-lock clipped the distal ureter far away from the tumor and nearby the bladder.

Fig. 5: extravesical cuff resection diagram.

Fig. 6: Schematic diagram of one cut followed by one stitch.

the same time was adopted (Fig. 6). Bladder incisions were sutured with 3-0 absorbable threads.

The details of the Nephrectomy were as follows: Firstly, the posterior peritoneum was incised at the line of Toldt, allowing mobilization and displacement of the colon mesentery media to the aorta on the right and vena cava on the left. Along the previously dissected genital veins and ureters, the upwards-renal veins, arteries, and pelvis were searched and dissected. Hem-o-lok was used to clip the renal arteries and veins respectively and then we divided them. The kidney was fully mobilized typically outside of the Gerota fascia by a blunt and sharp combination method and the ipsilateral adrenal glands were retained. The details of the Lymph node dissection were as follows: Template lymph node dissection is considered for patients with clinically staged high-grade renal pelvic cancer or abdominal ureteral cancer combined with the >T2 cancer stage. For patients with left tumors, para-aortic lymph node dissection was performed. For patients with right tumors, paravenous lymph node dissection was performed. The area of the lymph node dissection ranges from the hilar plane to the bifurcation of the iliac vessels.The details of the Organ entrapment and extraction were as follows: The incision of the specimen selection: For right, sampling on the line between the camera port and the 1st robotic port. For left, sampling on the line between the camera port and the 2nd robotic port. The appropriate length of the incision was determined according to the size of the resected specimen. When removing specimens, the specimens should be placed in the specimen bag to avoid pulling out the specimens directly. The pelvic drainage tube and abdominal drainage tube were placed in the 1st robotic port and 2nd robotic port respectively.

Statistical Analysis

We used the software program SPSS 20.0 to conduct the statistical analysis. Continuous variables were expressed as mean± SD. Discontinuous variables were expressed as a percentage (%). We further recorded and analyzed the data of all patients who underwent the "one-step" robot-assisted laparoscopic nephroureterectomy, including age, sex, affected side, operation time, lymph node dissection, intraoperative blood loss, postoperative exhaust time, indwelling drainage tube time, postoperative pathology, and follow-ups of complications and the recurrence of tumors.

Results

The Surgical Results

9 patients successfully completed the operation without conversion to open surgery. The success rate of the oper-

Table I - *Basic data of surgical patients*

NO.	Age	Gender	BMI	Clinical diagnosis	Previous history
1	55	Male	24.6	Left renal pelvis carcinoma	Hypertension, Bilateral renal calculi
2	69	Female	25.1	Right renal pelvis carcinoma	Lumbar disc herniation,
3	64	Female	19.1	Right renal pelvis carcinoma	Hypertension, Diabetes, Hyperlipidemia
4	38	Male	31	Left renal pelvis carcinoma	–
5	75	Female	27.4	Left ureteral cancer	Hypertension, Diabetes
6	64	Female	21.7	Right ureteral B-cell lymphoma	–
7	65	Male	22	Left ureteral cancer	Coronary heart disease
8	62	Male	22.9	Left ureteral cancer	–
9	63	Male	29.2	Right renal pelvis carcinoma	Hypertension

Table II - *Surgical Result of 9 patients*

NO.	operation time(min)	blood loss (ml)	exhaust time (d)	Indwelling time of drainage tube (d)	Lymph node dissection	TNM staging	follow-up time (month)
1	248	300	2	5	No	T1N0MO	23
2	220	200	1	4	Yes	T3N0MO	18
3	250	100	3	6	No	T2N0M0	17
4	265	200	2	7	No	T1N0MO	14
5	229	200	3	5	No	T1N0MO	14
6	240	100	2	4	Yes	T3N0MO	9
7	254	100	1	5	No	T1N0MO	7
8	240	100	2	4	Yes	T2N0M0	6
9	240	200	2	6	No	T2N0M0	5

ation was 100%. The operation time was 242.89 +13.37 minutes, the blood loss was 166.67 +70.71ml, the exhaust time was 2 +0.71 days, the indwelling time of drainage tube was 5.11 +1.05 days, and the average follow-up time was 12.56 +6.19 months. There were no complications and recurrence of tumors. See Table II for details.

The Pathological Results

The pathological results include 1 case of high-grade non-invasive urothelial carcinoma of the left renal pelvis, 1 case of low-grade invasive urothelial carcinoma of the right renal pelvis, 2 cases of high-grade invasive urothelial carcinoma of the left renal pelvis, 1 case of high-grade invasive urothelial carcinoma of the right renal pelvis, 2 cases of low-grade non-invasive urothelial carcinoma of the left ureter, 1 case of high-grade invasive urothelial carcinoma of the left ureter, and 1 case of right ureteral non-Hodgkin's high grade B cell lymphoma.

Discussion

The outcomes of this study showed that the surgery was successfully completed in all 9 cases. The mean surgery duration was 242.89±13.37 minutes, the mean blood loss was 166.67±70.71mL, the mean exhaust time was 2±0.71 days, the mean retention drainage time was 5.11±1.05 days, and the mean followed up time was 12.56±6.19 months with no complications and tumor recurrence.

70% of ureteral tumors occur at the distal end of the ureter, 25% in the middle of the ureter, and 5% in the proximal end of the ureter [7-9]. Therefore, there are some controversies about the surgical methods of ureteral tumors. Zhang et al. proposed that the effect of total nephroureterectomy is similar to a partial ureteral resection [10]. Nazzani S et al. retrospectively analyzed the implementation rates of bladder cuff and non-bladder cuff in UTUC patients with total nephroureterectomy and concluded that bladder cuff increases the operation time but has no effect on the specific mortality rate of tumors and other causes of mortality [11]. Therefore, it is not possible to assess the recurrence and metastasis rates of bladder cuff resection-based tumors. However, Krabbe LM et al. holds the opposite view about whether the end of the ureter is treated or not. They support the standard bladder cuff method in nephrectomy and full-length ureter surgery [7]. At present, the standard operation of UTUC is still the nephrectomy, the full length of the ureter, and the bladder cuff [4].

Since Clayman et al. first reported laparoscopic total nephroureterectomy in 1991, one-step and two-step laparoscopic total nephroureterectomy has been tried more frequently [12]. In recent years, robotic-assisted endoscopic surgery has been rapidly promoted in China

because of its advantages of three-dimensional high-definition vision, flexible wrist manipulation, and high surgical accuracy. In the field of urology, this technology has been accepted and continuously improved and innovated. It is convenient for surgeons and also benefits the patients. Homas Stonier et al. made a retrospective comparative analysis between traditional laparoscopic and robotic-assisted laparoscopic nephroureterectomy [13] and found that robot surgery was not superior in operation time but had obvious advantages in the number of lymph node dissections, a positive rate of surgical margin, reduced recurrence rate of bladder tumors, reduced overall complications, and better postoperative mortality. Hakmin Lee et al. compared the efficacy of open, laparoscopic, and robotic surgery for non-metastatic UTUC patients [14]. Laparoscopic and robotic surgery had better results in the perioperative period, such as less intraoperative bleeding, shorter hospital stays, less use of painkillers, and non-inferior oncologic results.

At present, many surgeons can successfully complete the removal of a kidney and upper ureter. In 2014, Yang et al. reported the experience of robotic-assisted laparoscopic nephroureterectomy for UTUC in Taiwan [15]. Twenty patients from three local medical centers were analyzed and the surgeons still needed to re-adjust the position of the machine and reconnect to perform the end-of-ureter resection after the robotic nephrectomy but there was no need to re-adjust the patient's position; Hu et al. also compared robotic-assisted and hand-assisted laparoscopic nephroureterectomy and concluded that robotic-assisted nephroureterectomy has more advantages in terms of blood loss, recovery of food after the operation, and a shortened hospital stay [16]. However, the robotic-assisted nephroureterectomy method mentioned by them also needs two steps. For the lower ureter and bladder wall resection, the two-step method needs to change the operation mode and reposition. This method not only lengthens the operation time and increases the difficulty of the operation but also increases the patients' experience with pain and the related risks of the operation. Since the robot arm is bulky, it requires higher assembly space and operation space; the robot-assisted laparoscopic nephroureterectomy without re-docking in a single position can easily cause collision and interference between devices and cannot reach the target area. Drawing on the experience of other urological robotic surgical teams, our center has formed our own robot-assisted laparoscopic nephroureterectomy device used without re-docking in a single position, which effectively avoids the abovementioned problems [17].

Our experience was as follows: (1) Patient's body position: Patients were placed in a 70 degrees healthy side reclining position, pad high waist, head down position. This position relaxes the patient's waist, causes the intestinal tract to fall to the horizontal side and increases the abdominal space, which is convenient for the design of the robotic port and equipment connection. (2) Robot port placement: The position of camera port was at a horizontal umbilical level at the lateral rectus line on the operation side. With this as the center, the cranial robotic port was 8 cm away from the camera port on the lateral rectus; the caudal robotic port was located at 8cm on the straight line with 120° angle between the cranial robotic port and the camera port. Furthermore, the third robotic port was placed between the umbilicus and the pubis and was 2 cm higher than the pubis. This design facilitates the connection of the patient card and instruments, avoids crossing and collision, and also facilitates the consideration of the pelvic ureter while using a bladder cuff and abdominal nephrectomy without changing the patients' body position and re-docking. Our method reduces the difficulty of the operation, shortens the operation time, and alleviates the pain experienced by the patients (3). Equipment connection: The midpoint line of the angle between the1st arm and 2nd arm guides the direction of the patient card. The docking position is adjusted according to the "sweet spot" range of the camera arm. In order to facilitate docking into the designated position, we adjust the direction and position of the operating bed to match the docking direction, rather than blindly adjusting the patient card, which would make docking more difficult because of the limitation of the operating room space. (4) Instrument cooperation during the operation: Hem-o-lock is often used at the distal end of the ureter near the bladder in order to avoid urine spillover and implantation from the lower ureter or upper ureter. When the intramural ureter is excised, the pelvic space is narrow and the working distance of the cranial manipulator is long, which limits the mobility of the instrument. In order to prevent urine overflow and tumor implantation from the bladder, we needed to adopt the form of one cut followed by one stitch. At this time, it was very important to manipulate the cooperation between the doctors and assistants. The assistant hand scissors were used to cut the bladder cuff. With each point cutting, the surgeon sutures the bladder with a 3-0 absorbable suture. The assistant cut and the surgeon sewed at the same time until the bladder cuff was completely removed (5). Specimens' entrapment and extraction: The specimens were placed in sterile bags under an endoscopy. The suitable length of the connection between the camera port and the cranial robotic port was taken from the body surface (estimated according to the size of the specimen). A layer-by-layer incision was performed into the abdomen, the specimens were taken out, the indwelling drainage tube was performed, and the incision was closed using a layer-by-layer method.

The robot-assisted laparoscopic nephroureterectomy without re-docking in a single position simplifies the operation process but also has some shortcomings. For example, previous "two-step" or "three-step" procedures involved cystoscopy and transurethral resection of the bladder cuff. That procedure not only deals with the ori-

fice of the ureter but also clarifies whether there is a growth of the tumors in the bladder. The robot-assisted laparoscopic nephroureterectomy without re-docking in a single position does not involve cystoscopy. Therefore, in order to prevent missing the possible intravesical tumors, we should routinely perform a cystoscopy before the procedure. The European Association of Urology Guidelines on Upper Urinary Tract Urothelial Carcinoma (EAU's UTUC) also clearly indicates that a cystoscopy excludes concurrent bladder tumors as an "A" recommendation [18].

At present, the therapeutic effect of UTUC lymph node dissection is still controversial. Nessn H et al. retrospectively analyzed 298 UTUC patients who underwent lymph node dissection and found no difference in overall survival and tumor-specific mortality between N1 and N0 patients [19]. Guo et al. made a meta-analysis of lymph node dissection in UTUC patients. It was concluded that lymph node dissection could improve the staging and prognosis of patients but whether it could improve the survival of patients was unclear [20]. In addition, the EAU guidelines for invasive UTUC and retroperitoneal lymph node dissection are a "C" recommendation [18].

Limitations. Firstly, this trial was not a randomized controlled trial. Secondly, this study was only a single-center trial and the sample size was limited. Thirdly, the clinical follow-up was short and it was necessary to observe the long-term clinical prognosis.

Conclusion

The robot-assisted laparoscopic nephroureterectomy without re-docking in a single position simplifies the procedure and shortens the operation time. It is also a safe, effective, and feasible minimally invasive treatment method.

Riassunto

Questo studio intende valutare la esecuzione della nefroureterectomia laparoscopica assistita da robot senza riposizionamento del paziente.

Sono stati analizzati i dati clinici di 9 pazienti sottoposti a nefroureterectomia laparoscopica assistita da robot tra maggio 2017 a novembre 2018, procedendo in una unica posizione, senza riposizionamento del paziente. Si è trattato di 5 uomini e 4 donne, di età media di 61,67 ± 10,37 anni e un indice di massa corporea (BMI) medio di 24,78 ± 3,84. Abbiamo considerato la durata dell'intervento, la perdita di sangue, la durata della degenza, la durata di mantenimento del drenaggio e il follow-up su tutti i pazienti, con o senza complicazioni e recidiva del tumore.

Risultati: l'intervento è stato completato in tutti e 9 i casi. La durata media dell'intervento era di 242,89 ± 13,37 minuti, la perdita media di sangue era di 166,67 ± 70,71 ml, il tempo medio di degenza era di 2 ± 0,71 giorni, il tempo medio di mantenimento del drenaggio era di 5,11 ± 1,05 giorni e i tempi medi di follow-up senza le complicanze e la recidiva del tumore sono state di 12,56 ± 6,19 mesi.

Conclusione: la nefroureterectomia laparoscopica assistita da robot senza riposizionamento del paziente durante la procedura semplifica l'intervento e ne accorcia la durata di esecuzione. Si tratta anche di un metodo di trattamento minimamente invasivo sicuro, efficace e fattibile.

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