

Application of Polymer Clip to Ligate the Distal Ureter in Retroperitoneal Laparoscopic Radical Nephroureterectomy

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Research

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Abstract

Purpose Distal ureter management in radical nephroureterectomy (RNU) is challenging.

Methods: This study describes a simple endoscopic clip technique with polymer clip ligation for the management of the distal ureter during retroperitoneal laparoscopic RNU. This endoscopic technique was used in 14 patients with upper tract urothelial carcinoma (UTUC). Transurethral resection of the bladder cuff was performed using a bipolar β electrode (mounted on resectoscope). Subsequently, a Super Scope (S-scope) with a 5-mm-diameter dual working channel was used with clip applicator to deliver the polymer clips, which consequently ligated the ureteral stump and avoided urine spillage from the upper tract.

Results: Distal ureter was managed successfully in all 14 cases using polymer clip, without any cases of urine spillage.

Conclusions: Therefore, polymer clip ligation technique provides a simple and safe option for distal ureter management in retroperitoneal laparoscopic RNU.

Introduction

The standard treatment of non-metastatic upper tract urothelial carcinoma (UTUC) is radical nephroureterectomy (RNU) with bladder cuff excision (BCE) (1). An optimal management of the distal ureter ensures complete BCE while avoiding tumor/urine spillage; however, there is currently no uniform method to achieve the best oncological outcome (2). The rate of intravesical recurrence (IVR) after RNU for UTUC is high (3–5). The controversy of the management of the distal ureter during laparoscopic nephroureterectomy (LNU) remains an issue (6–8). Our center has performed loop ligation for many years, which is very similar to the method reported by Agarwal (9), but the procedure remains difficult. The operator and assistant must work in close cooperation to ensure its success; nonetheless, the ligation loop may occasionally detach during the operation. In our study, a Super Scope (S-scope) with a 5-mm diameter working channel was used with clip applicator to deliver the polymer clips. We attempted transurethral polymer clip ligation at the distal ureter to completely avoid urine spillage, thereby eliminating the possibility of shedding of tumor cells; this also established the accurate closure and removal of cancerous cells.

Patients And Methods

Between April 2020 and April 2021, 14 patients whose UTUC being diagnosed by pathology or imaging were included in this study. This study was approved by the ethics committee and institutional review board of Chinese PLA General Hospital. All patients gave informed written consent.

Polymer Clip

Polymer clip (103Y.301) was manufactured by Hangzhou Kangji Medical Instrument Co., Ltd. This clip is a non-absorbable multi-polymer material ligation clip without tissue reaction and artifacts and widely used in laparoscopic surgery for clamping blood vessels and tissues, with the advantages of easy operation, accurate closure clamping and not easy to fall off.

Surgical procedures

1. Endoscopic clip ligation and release of the distal ureter

Under general anesthesia with tracheal intubation, the patient was placed in the lithotomy position. Cystoscopy is performed in a standard way to rule out any active bladder tumor disease. A resectoscope mounted with bipolar β electrode (Jiangsu BONSS Medical Technology Co. Ltd) (Figure 1) was placed, while the area around the ureteral orifice on the affected side was incised until the deep muscle layer of the bladder was accessed through electrosurgical resection (Figure 2). Then, the intravesical ureter as separated from the bladder. The resectoscope was replaced with a dual-channel Super Scope (S-scope, manufactured by Shenyang Shenda Endoscope Co. Ltd.), and then a clip applicator (Figure 3) was inserted through a 5-mm working channel to deliver polymer clips to ligate ureteral stump (Figure 4). An indwelling 20F urinary triple-lumen balloon catheter was placed after the fluid in the bladder was completely flushed out.

2. Retroperitoneal laparoscopic radical nephroureterectomy and en bloc specimen retrieval

Subsequently, the patient was placed in the contralateral position, with the lumbar bridge lifted. A 2-cm incision was made along the posterior axillary line below the costal margin of the 12th rib; the muscle layer and fascia of the lower back were separated thereafter. A self-made balloon was placed and inflated with 500 mL air to expand the retroperitoneal space. The other two channels were located along the anterior axillary line under the costal margin and along the midaxillary line 1 cm from the upper margin of the iliac crest. Under laparoscopy, the renal artery and vein were exposed and severed, leaving only the ureter connected. The procedure for renal pelvic cancer and cancers of the middle and upper ureters includes a 6-8 cm incision extended obliquely from the anterior axillary line incision to the lower abdomen. The surgeon extended a hand into the incision and followed the ventral side of the ureter with a finger until polymer clip was palpable; the surrounding structural tissues were gently pulled and twisted using the fingertip, which allowed complete grasp of the ureter and removal from the body along with the specimen. For the lower ureteral cancer, an abdominal Gibson incision was used; the specimen was removed, while the lower ureter was separated by direct vision.

Results

This technique was performed in 14 patients: 10 men and 4 women. Age ranged from 46 to 76 years (mean 62.6 years). Tumor was in the renal pelvis in 12 patients and in the upper ureter in 2 patients. Polymer clip ligation release of the distal ureter (Figure 5) was successful in a single operation in all patients. Mean surgical time for cystoscopy and retroperitoneal nephrectomy was 14.8 minutes (range

10-20 minutes) and 107.7 minutes (range 75-140 minutes), respectively. There was minimal intraoperative blood loss (mean 4.6 ml) during the bladder procedure. No patients required blood transfusion. Drain was removed on day 2 post operation. Histopathology showed pT2 disease in 8 patients and pT3 disease in 6 patients. Outer and distal margins were clear in all patients. Postoperative follow-up ranged from 4 to 18 months. There were no cases of ureteral rupture or Clavien-Dindo grade III–IV complications. Surveillance cystoscopy showed no intravesical recurrence.

Discussion

In this study, the application of polymer clip to ligates the ureteral stump in retroperitoneal LNU was investigated. After transurethral BCE, a dual-channel resectoscope was used, and a 5-mm clip applier was used to deliver polymer clip, which ligated the ureteral stump. Thus, transurethral ligation of the distal ureter using polymer clip is a simple procedure that ensures accurate closure.

The internationally recognized extent of resection for nephroureterectomy includes the full-length ureter and the kidney, as well as the ureter in the intramural segment of the bladder; however, there are no uniform guidelines for the resection of the lower ureter and intramural ureter. Furthermore, the current operation methods do not completely address the issue of ureteral orifice closure. This does not conform to the principle of “tumor-free” zone, wherein the complete BCE and control of tumor/urine spillage into the operative field are not ensured. Therefore, the rate of intravesical recurrence after nephroureterectomy for UTUC is high (3–5).

Currently, in LNU, a working channel is added in the lower abdomen after retroperitoneal laparoscopic nephrectomy. The lower section of the ureter, particularly the intramural ureter and peri-vesical space, is managed in the same position. Although this operation is performed under direct vision, difficulties such as operator discomfort and unsatisfactory surgical field of view remain (10–12).

Many surgeons prefer transurethral resection of the intramural ureter for various reasons. First, transurethral BCE is performed under cystoscopy. After the distal ureter is surgically freed, the entire bladder cuff is pulled out of the bladder. This method effectively prevents additional surgical incisions and reduces the duration of the operation compared with open resection (13). However, a disadvantage of this method is that the risk of tumor and urine spillage will be increased after the bladder cuff is pulled out, resulting in postoperative seeding of tumor cells and local recurrence (14). Guo *et al.* performed continuous wave laser for the distal ureter after BCE in an attempt to close the distal end, but the outcomes were difficult to quantify and unsatisfactory (15). Sotelo *et al.* punctured the suprapubic region and ligated the distal ureter, which not only caused additional injury but also did not meet the “tumor-free” principle (16).

The polymer clip is a commonly used and most reliable device for vascular control in laparoscopic procedures. Moreover, clamping the distal ureter after a transurethral BCE is undoubtedly the most effective method to avoid shedding of tumor cells. However, due to the limitations of the current transurethral surgical instruments, polymer clip cannot be used during transurethral surgery; therefore,

closing the stump of distal ureter remains difficult. The S-scope used in this study has the unique and advantageous feature of a relatively wide working channel, through which 5-mm-diameter laparoscopic instruments such as ultrasonic scalpel and suction device, as well as 5-mm clip applier, can be passed, allowing the ureteral stump to be easily clamped.

We believe that the transurethral closure of the distal end of the ureter using polymer clip has several advantages. First, accurate closure of the distal end of the ureter is possible. The polymer clips are usually used to close renal arteries and veins; the pressure of arterial blood is much higher than that of urine in the ureter. Therefore, it is effective in closing the ureter and can completely avoid urine spillage into the bladder or surgical field. Second, the 5-mm clip applier used is simple; therefore, it can be completed by a single operator and involves a short learning curve. Third, in the process of tissue removal, polymer clip is tightly fixed and cannot detach. Fourth, when electrosurgical resection is performed for hemostasis of the bladder wall, polymer clip does not burn. Fifth, regardless of the operation, ligation of the distal ureter can prevent compression and pulling of the ureter, even in the lower ureter, thereby ensuring that tumor cells do not enter into the surgical field. Sixth, the polymer clip at the distal end of the ureter can be used as a landmark to verify whether the full-length ureter has been excised or if any stump has been missed. Lastly, the polymer clip is low in cost and represents a small economic burden to the patient.

In addition, the transurethral BCE of the ureteral orifice is convenient for observing residual cancer in the bladder. If remnant cancer lesions are noted, they can be removed concurrently. In addition, no episodes of intra-abdominal spillage of blood and urine occur and there is limited interference with the abdominal organs because both nephrectomy and lower ureterectomy are completed in the retroperitoneal space.

Our technique also includes a number of limitations. First, after the cuff around the ureteral orifice is removed, it must be replaced with a specialized instrument before the clip applier can be inserted to close the ureteral stump. Second, the lateral decubitus position must be changed during nephrectomy, which prolongs the duration of anesthesia. Given the complex nature of UTUC, we believe that cystoscopy in the lithotomy position is beneficial for determining remnant cancer lesions in the bladder. Third, since the bladder incision is not sutured after BCE, a bladder wall defect is created, which is difficult to suture with available techniques and equipment. Nonetheless, an indwelling urinary catheter can be used for 7-10 days to maintain the bladder empty until the defect closes naturally. Although the closure of these bladder defects has been reported (17), this procedure remains difficult. Lastly, the patients in this study lack long-term follow-up, warranting further observation and evaluation.

In summary, the cystoscopy surveillance, RNU with BCE, the polymer clip ligation, and retroperitoneal laparoscopic nephrectomy effectively reduces intravesical recurrence.

Abbreviations

RUN Radical nephroureterectomy

UTUC Upper tract urothelial carcinoma

BCE Bladder cuff excision

IVR Intravesical recurrence

LNU Laparoscopic nephroureterectomy

Declarations

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Authors' contributions

CYW and SKS wrote the article; CYW, HKY, YS and LZ processed the data analysis; FZ, WJF, and GFC conceived of this study; SKS and XZ revised the final manuscript. The authors read and approved the final manuscript.

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Consent for publication

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Figures



Figure 1

Bipolar β electrode.

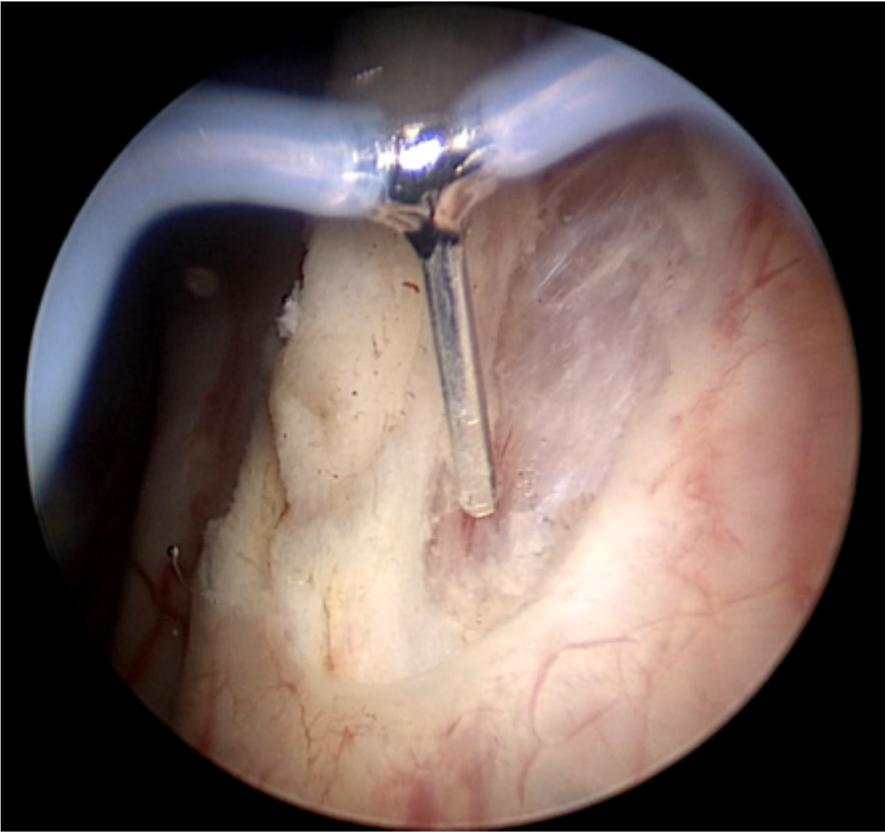


Figure 2

β electrode for cuff excision of the ureteral wall.



Figure 3

Clip applicator and S-scope.

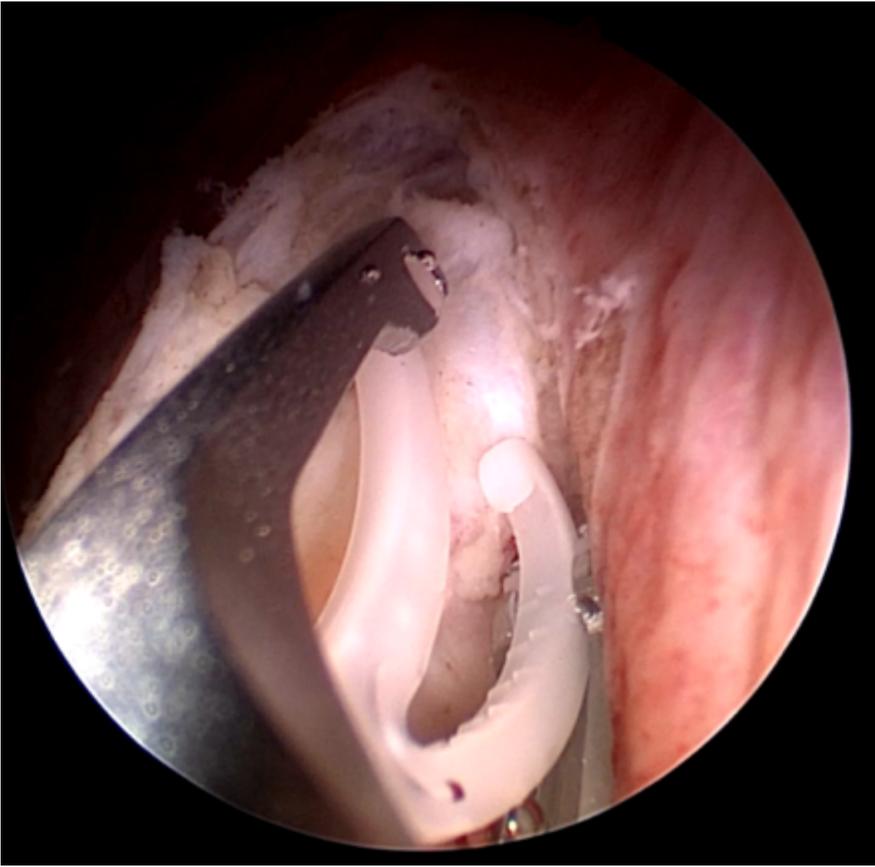


Figure 4

Polymer clip for ligating the distal ureter.



Figure 5

The completely resected ureter.