

# Complete laparoscopic nephroureterectomy with intravesical lockable clip

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## KEY WORDS

nephrectomy ▶ ureter ▶ urothelial carcinoma ▶ laparoscopy

## ABSTRACT

**Introduction.** We present a cohort of patients with low-stage pelviureteric neoplastic disease who underwent complete laparoscopic nephroureterectomy (CLNUE) with intravesical lockable clip (IVLC). Due to the absence of a standard technique of NUE, the study was not randomized.

**Materials.** From 1/2010 to 1/2012, 21 patients were subjected to CLNUE-IVLC. The first step was transurethral excision of the ureterovesical junction with Collin's knife deep into the paravesical adipose tissue. The ureter was grasped with biopsy forceps and the distal end of the ureter was occluded with lockable clip. The applicator was introduced through a 5 mm port inserted as an epicycstostomy. The patients were rotated to flank position and CLNUE followed. The endoscopically introduced clip on the distal ureter is proof of completion of the total ureterectomy.

**Results.** The mean operation time was 161 (115-200) min. In four (19.0%), the application of the clip failed and CLNUE was completed with non-occluded ureter. In three cases, subsequent laparoscopic nephrectomy was converted to open surgery. In two cases, the distal ureterectomy was completed with pluck technique through a lower abdominal incision that was also used for extraction of the specimen. There were four complications (Clavien II 2x, IIIb, V). Follow-up was available for all – mean 10.6 (range: 0-25) months. One died of disease generalization within 11 months.

**Conclusion.** CLNUE-IVLC is fast and safe. If needed, the endoscopic phase can be switched to open NUE. Disadvantages include: the need to change the position of the patient, the risk of inability to apply the clip on the distal ureter, and the risk of an unclosed defect of the urinary bladder.

## INTRODUCTION

Despite expanded indications for conservative surgery of urothelial tumors (UT – formerly transitional cell carcinoma) of the upper urinary tract (UUT), radical nephroureterectomy (NUE) with complete removal of the distal ureter including the bladder cuff is the standard surgical technique used for most patients with UT of the UUT.

Choosing the best procedure for this group of patients in everyday clinical practice is frequently a challenging task. While laparoscopic nephrectomy as a part of NUE was first described in 1991 [1] and it is to-date broadly accepted [2], the approach to the distal ureter and the timing of the ureterectomy are still disputed [3]. Several techniques have been developed to remove the distal intramural part of the ureter during laparoscopic NUE and it is very difficult to choose the best procedure for a given patient in everyday clinical practice.

Complete laparoscopic NUE (CLNUE) has previously been performed with a stapler [4]. There is a risk of residual tumor at the stapling site and titan clips may constitute a nidus for the formation of cystolithiasis [5, 6].

Two groups [7-9] have described a technique for the division of the ureterovesical junction with a thermo "sealing" system (Ligasure® Atlas®). We considered this modification of CLNUE as an excellent method and we have previously performed this on 14 patients. However, we found a significant risk of incomplete resection of the intramural part of the ureter [10]. For this reason, we have been searching for another method of CLNUE.

Exclusive laparoscopic sharp excision of the bladder cuff with intracorporeal suturing [11-15] appears too difficult for us. Thus, we have decided to start CLNUE with excision of the ureterovesical junction with Collin's knife followed by CLNUE. The main problem with this procedure is the risk of occlusion of the ureter to prevent spillage of urine containing tumor cells during laparoscopic pluck nephroureterectomy. Several methods have been described to date: (1) cauterization of the ureteric ostium only, (2) endoloop [16, 17], (3) Hem-o-lok® clip [18-20], or (4) fibrin sealant [21].

We chose to close the ureter with a lockable Hem-o-lok® clip, which was introduced through a 5 mm intravesical port in the suprapubic area rather than endoscopically [18,19,20]. We have labeled this technique as CLNUE-WILC (with intravesical lockable clip). In this study we characterize the applicability of this technique and report our experiences.

## MATERIAL AND METHODS

The study is prospective, but due to the absence of a standard technique for NUE, the study was not randomized and comparative. From 1/2010 to 1/2012, 38 patients with suspected UT of UUT were indicated for surgical treatment. Four underwent conservative surgery (one Ho:YAG ablation, one ureteroscopic resection, one nephroscopic resection with resectoscope, and one open resection of the ureter) and 34 NUE. Thirteen underwent some type of open surgery (advanced cases with open nephrectomy or laparoscopic nephrectomy with open ureterectomy for tumor of the distal ureter) and 21 NUE by CLNUE-IVLC (main inclusion criteria: not suitable for conservative treatment, no tumor of distal ureter, no advanced tumor by CT, no contraindications to laparoscopy, or no concomitant bladder tumor).

Table 1. Results in details

Number	Sex	Age	Side	Localization of tumour	CLNUE	Open nephrectomy	Open distal ureterectomy	Time of surgery	Blood loss	Hospital stay	Failed Weck	Notes	Open approach, complications	Follow-up	pT	Grade	Histology	Follow-up (months)
1	M	84.1	L	UM			1	200	100	NA	1		Open distal ureterectomy	Death from heart failure in day of operation	2	1	UC	0.0
2	M	55.8	R	P	1			165	0	8					1a	2	0-PRCC	24.7
3	M	68.0	L	P	1			140	200	7	1	History of recurrent BT (pT1G2), TURBs, BCG		UC of the right ureter and ostium, death for generalisation to skeleton in 11.1 months	a	1	UC	11.1
4	M	72.1	L	P	1			180	100	12					2	2	UC	20.9
5	M	77.9	R	P	1			170	100	8					3a	1	CRCC	19.3
6	M	65.9	R	UP	1			180	150	14	1		2 <sup>nd</sup> post-op day open PE for bleeding		0	0	inflammation	17.5
7	M	81.6	L	P	1			150	150	9	1				2	2	UC	17.1
8	M	59.5	R	P	1			115	50	9		History of recurrent BT, TURBs, BCG			1	1	UC	15.8
9	M	76.1	R	P	1			115	0	8					3	2	UC	15.4
10	M	67.2	R	UM			1	150	500	13		History of TU-RB fro BT pT1G2, ESKD, hemodialysis	Open nephrectomy (history of suphrenic abscess)		a+CIS	2	UC	14.9
11	M	82.9	R	P	1			130	150	8		UC of L ureter at the same time, Ho:YAG laser ablation, ESKD		3Mo after NUE, hemodialysis started	2	2	UC	14.5
12	M	52.6	L	UM			1	190	100	7			Open distal ureterectomy		a	1	UC	14.0
13	M	70.0	L	P	1			140	100	6					1	2	UC	9.0
14	M	66.9	R	UP			1	140	150	11			Open distal ureterectomy		1	2	UC	7.3
15	M	71.2	R	P	1			180	10	18			Abscess of wound – Staphylococcus aureus		1	2	UC	7.1
16	M	58.0	R	UP			1	180	500	11			Open nephrectomy (fixation to surrounding structures)		4	1	Metastasis of colorectal cancer	4.0
17	M	65.4	R	P			1	190	600	7			Open nephrectomy (fixation to surrounding structures)		3	3	UC	3.5

18	M	65.2	R	UM			1	195	350	8		Previous URS and stent	Hem-o-lok size L, open distal ureterectomy (2 cm)	1	3	UC	2.7
19	M	61.4	R	P	1			142	200	6				3	3	UC	2.2
20	M	77.0	R	P	1			140	0	9		Urinary leakage from drain 6 days		1	1	UC	1.6
21	F	58.2	L	P	1			185	0	8				3	1	UC	0.3
	Mean	68.4			14	7	160.8	167.1	9.4	4						Mean	10,6
	SD	9.1			67%	33%	26.5	175.8	3.0	19,0%						SD	7,5
	Min	52.6					115.0	0.0	6.0							Min.	0,0
	Max	84.1					200.0	600.0	18.0							Max.	

Abbreviations: AE – adrenalectomy for adenoma, BCG – history of intravesical instillation of BCG, BT – urinary bladder tumor, ESKD – end-stage kidney disease, L – left, M – male, Mo – month(s), O-PRCC – oncocytic papillary renal cell carcinoma [29], P – renal pelvis, R – right, TURB – transurethral resection of bladder tumor, UP-UM – ureter proximal-middle, UC – urothelial carcinoma, URS – diagnostic ureteroscopy. Notes: All cases were NOMO; Time – of whole procedure (endoscopy, rotation of patient, laparoscopy); Non-UC histology: Tumors were described by radiologists on CT/MRI as a suspicious UC tumor.

Technique of CLNUE- I VLC: The procedure starts in the lithotomy position with endoscopy. The ureterovesical junction is excised transurethrally with Collin's knife (the paravesical adipose tissue must be clearly visible). From the suprapubic region, a 5 mm port is introduced in the urinary bladder. The stump of the ureter is grasped with biopsy forceps and on the end of ureter, a Hem-o-lok® clip size ML is applied (the applicator is introducible through the 5 mm port). In broader ureters, a 10 mm port and size L clips may be used. The patient is rotated to the flank position and a standard laparoscopic nephrectomy via a transperitoneal approach is performed [10, 22]. The transperitoneal approach is more familiar to us than the retroperitoneoscopic one. The ureter is not divided. One additional 5 mm port in the suprapubic region is introduced; the skin incision from the previous endoscopic phase is used. The gonadal vessels are transected. The peritoneum is incised above the ureter up to the urinary bladder. The ureter is dissected along and under the iliac vessels with a harmonic scalpel or Ligasure® Advance® or Blunt tip 35 mm®. This phase is delicate due to the relatively narrow operation space and the close relation of iliac vessels and the bowel. The ureter is completely separated and the Hem-o-lok® clip must be clearly visible to constitute proof of completion of the ureterectomy. The urinary bladder stays unclosed. A pelvic drain is placed through a port in the suprapubic area. The specimen is extracted in a bag through a lower abdominal muscle splitting incision. A catheter is left for seven days. A standard postoperative follow-up is conducted according to established protocols of UT of UUT. All CLNUE-I VLCs were performed by three endoscopically and laparoscopically experienced surgeons.

## RESULTS

The clinicopathologic data and results are summarized in Table 1. A few points to emphasize include: four complications (Clavien II 2x, IIIb and V) [23] – wound infection at the site of extraction (*Staphylococcus aureus*), urine leakage from the pelvic drain for 6 days (bladder catheter was removed on the 8<sup>th</sup> postoperative day following cystoradiography that did not reveal leakage), one open prostatectomy on the 2<sup>nd</sup> postoperative day because of an enlarged prostate (BPH with hematuria), and one patient died of heart failure on the day of operation. In four cases (19.0%) application of the clip failed and CLNUE was concluded with a non-occluded ureter and the risk of dissemination of tumor cells in urine paravesically. In the first case the patient had a ureteral stent and the ureter was incrassate, which is why we did not want to apply 10 mm port to facilitate the introduction of the Hem-o-lok® clip size L. In another case, the stented ureter was also incrassate and we introduced a 10 mm port to the urinary bladder and applied a size L clip without difficulty. There was one incidence with the inability to grasp the ureter by endoscopic forceps. In two cases the intramural ureters were cut by Collin's knife. In three cases the laparoscopic nephrectomy was converted to the open surgery (flank incision and lumbolaparotomy) – in one case this was due to extensive adhesions in the abdominal cavity (a history of open cholecystectomy with evacuation of subphrenic abscess), and in the other two cases it was due to advanced tumor growth with perirenal and periureteral adhesions. In three cases, laparoscopic nephrectomy was followed by open distal ureterectomy with the standard pluck method, because the laparoscopic approach was not feasible due to poor access of the laparoscopic instruments to the small pelvis. The incision was also used for extraction of the resected specimen. Four patients with non-UT histology were judged to be UT by preoperative imaging. Follow-up (mean 10, range: 0-22 months), including results of the control endoscopy, are known in all patients. One patient with UC of the renal pelvis pT2N0M0G2 had UC in the contralateral distal ureter and died after 11 months due to extensive metastatic disease, mainly to bone.

## DISCUSSION

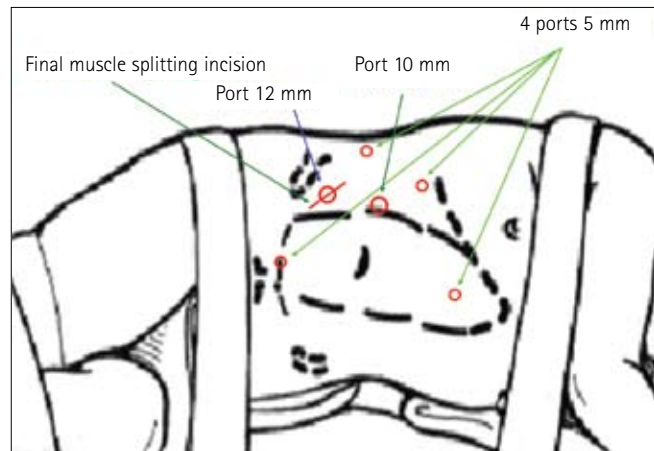
It should be noted that the aim of this work is not to comprehensively discuss the whole complex problem of NUE. Our experience prompted us to review this topic in two recent publications [10, 22] and now we will focus the discussion on complete laparoscopic NUE with emphasis on the method of removing the distal part of the ureter including the bladder cuff. In our



**Fig. 1.** The steps of the endoscopic phase in lithotomy position. The ureterovesical junction is excised transurethrally with a Collin's knife to the paravesical adipose tissue. The stump of the ureter is grasped with biopsy forceps and the end of the ureter is clipped with a Hem-o-lok® clip size ML (an applicator is introduced through the 5 mm port inserted as an epicystostomy).

view, due to the disadvantages mentioned in the introduction, the method involving a stapler should be abandoned. The other options of distal ureterectomy as a part of CLNUE are as follows: (1) a thermosealing technique [7, 8, 9], (2) the sharp excision of the bladder cuff with intracorporeal suturing (a purely laparoscopic technique) [11, 12, 15] including modification with a bulldog clamp [13], (3) robotic [24], or (4) purse string technique [14].

As pointed out previously, the thermosealing system technique has the risk of leaving the intramural part of the ureter intact [10]. The laparoscopic NE with ensuing sharp excision of the ureterovesical junction and closing of the defect with suture is an ideal but challenging method. This method has several modifications as mentioned above. We consider the technique with any variant intracorporeal suturing technically more challenging and time consuming [10, 22]. The variant with the da Vinci robotic system [24, 25] decreases the technical difficulty of intracorporeal suturing. The disadvantages of the da Vinci system include: high cost, lack of tactile sensation, long set-up time, and unavailability of the robotic system in many hospitals. An exotic technique is the pneumovesicum approach [26] in which three 5 mm ports are introduced to the bladder and insufflated with CO<sub>2</sub> – pneumovesicum (10–12 mm Hg). The distal ureter, bladder cuff, and intramural ureter are then completely dissected free using electrocautery. As soon as the distal ureter is dissected an endo-loop knot is used to ligate

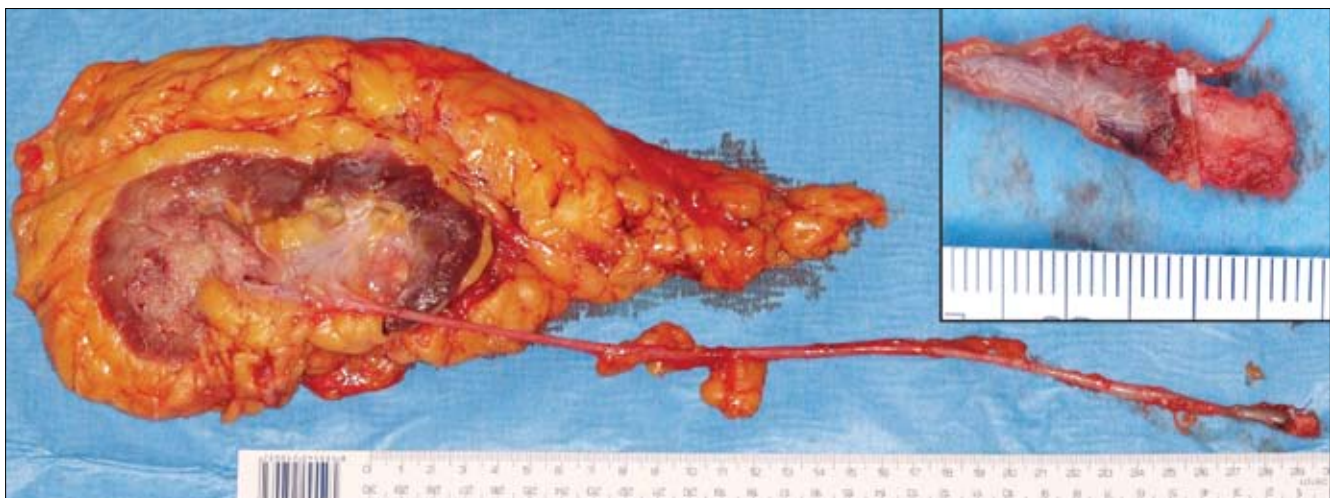


**Fig. 2.** Ports for left side nephroureterectomy. Six ports, on the left side, but five usually suffice. The same skin incision as for the epicystostomy is used for the suprapubic port.

the ureter. We do not have experience with this technique and we feel this technique to be complicated. Sotelo et al. have used the pneumovesical technique as well. The ureter is excised through a laparoscopic single port introduced to the urinary bladder and the defect is closed with intravesical suture [27].

Due to the factors mentioned above we prefer a variant of excision of the ureterovesical junction but with another method for sealing of the ureter. We have long-term experience with excision of ureterovesical junctions using Collin's knife. Previously we used it as a pluck technique combined with open and thereafter laparoscopic or retroperitoneoscopic nephroureterectomy, and, later on, we also used it as a part of antegrade mini-invasive NUE [22].

We found Pathak et al.'s idea [18, 19] of endoscopically closing the excised ureter with lockable clip to be excellent, although the introduction of the Hem-o-lok® clip via endoscope appears to be difficult. Pathak et al. performed their technique in 25 cases with a mean total operative time of 164 (range: 105–235) minutes. No pelvic complications were reported and there were no perivesical tumor recurrences with mean follow-up of 26 (range: 11–44) months. We have decided to apply the Hem-o-lok® clip size ML via an intravesical 5 mm port introduced through the suprapubic area. Regarding our first nine cases, we had found the exact same method described in the literature [20]. This work has strengthened our approach. Ahlawat et al. [28] published another three



**Fig. 3.** The dissected nephroureterectomy specimen during the operation. The tumor can be seen in the upper calyx with Hem-o-lok® size ML at the end of the ureter (see detail).

cases in 2011 with almost the same technique. The authors labeled this technique "suprapubic transvesical single-port technique for control of lower end of ureter during laparoscopic nephroureterectomy".

Reportedly, occlusion of the ureter may be performed instead of clip with electro-coagulation only (it is probably less reliable) or with fibrin sealant injection [21].

## CONCLUSION

CLNUE- IVLC is a relatively simple, reproducible, and minimally invasive method with minimal risks of tumor spillage and seeding. The main disadvantage seems to be the risk of an unclosed defect of the urinary bladder, but based on our own experience, as reported in this paper and the available literature, we have not found any significant complications emerging from this. Another disadvantage is failure in applying the Hem-o-lok® clip, in which the technique is concluded without closing the ureter, and is generally thought to carry a higher risk of extravascular tumor recurrence, but as described recently, this technique has comparable oncological results to the open distal ureterectomy [3, 6]. Failures in clip application were experienced only in early cases and, with increasing experience, this problem was avoided. Importantly, if needed, the endoscopic phase can be transformed to open NUE or it can be combined primarily with open surgery. Some may consider conversion to open distal ureterectomy/nephrectomy as a failure of the method. The method whereby closing of the ureter is performed allows the procedure (NUE) to be completed safely in complicated cases (obesity, advanced cases, previous intraabdominal surgery etc.).

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