

Transperitoneal laparoscopic heminephroureterectomy in the pediatric population: A single-centre experience using a sealing device

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Abstract

Introduction: We sought to report the outcomes of transperitoneal laparoscopic heminephroureterectomy (LHNU) in a pediatric population and to describe the technical details of this minimally invasive surgery.

Methods: Seventeen pediatric patients (18 renal units), who had consecutive transperitoneal LHNU in our department between January 2012 and July 2017 were included in the study. In all patients, diagnostic cystoscopy and retrograde pyelography were carried out immediately before the operation. A catheter was inserted in the unaffected ureter and fixed. LHNU with a transperitoneal approach was carried out in all patients with the aid of LigaSure®. After removal of the specimen, the intervention was finalized with the insertion of a drain. All intraoperative and postoperative data of the patients were recorded prospectively.

Results: The average age of the patients was 55.9±35.8 months (range 8–121). The average duration of the operations was 121.7±24.0 minutes (range 100–200). The average hospitalization time was 1.6±0.4 days (range 1–2). No intraoperative complication occurred in our patients. The average followup period was 29.1±13.4 months (range 4–48). During the followup period, no complications were observed except one patient who had pyelonephritis within the first month of surgery.

Conclusions: Transperitoneal LHNU is a minimally invasive method that can be used safely in pediatric patients. Using a standardized technique during the procedure is critical to increase the success and decrease the complication rates.

Introduction

The duplex collecting system is one of the common anomalies of the urinary system and as a result, the function of the upper or lower kidney poles are often decreased or lost due to the vesicoureteral reflux (VUR) or distal ureteral obstruction.^{1,2} In such cases, the surgical resection of the

non-functioning renal pole might be necessary.² The first bilateral laparoscopic heminephroureterectomy (LHNU) was performed by Jordan and Winslow in a pediatric patient who had bilateral duplex collecting system in 1993. Thereafter, this method became an effective alternative in the treatment of this disorder.^{3,4} The use of this method increased in the treatment of the pediatric patients due to less pain, shorter hospitalization time, and better cosmetic results compared with open surgery.^{2,5} However, as the implementation of this technique in children is rather difficult, its use remained limited.² LHNU can be performed with transabdominal (transperitoneal), lateral retroperitoneoscopy, and posterior retroperitoneoscopic approaches.^{3,6,7} In addition, robot-assisted approach is also described in the literature.¹ The advantages of using the transperitoneal laparoscopic approach include achieving larger working space and easier access to the upper pole.^{8,9} This study includes a retrospective evaluation of the outcomes of patients with a duplex collecting system who were treated with transperitoneal LHNU.

Methods

A total of 17 pediatric patients (13 females and four males for a total of 18 renal units) who had consecutive transperitoneal LHNU by a single surgeon in our clinic between January 2012 and July 2017 were included in the study. One female patient had bilateral duplex collecting system. The demographic characteristics of the patients, duration of the operations, the number of the used ports, complications, the need for analgesics, duration of the hospitalization, and followups were recorded retrospectively. The anatomical characteristics of these patients are shown in Table 1. In all of the patients, diagnostic cystoscopy and retrograde pyelography were carried out immediately before the operation. With the retrograde pyelography, a 3 F catheter was inserted into the normal ureter and was fixed to the urethral catheter. After the patients were placed in a 60° lateral flank position, the first trocar (5 mm) was inserted through the upper side of the umbilicus with the Hasson method. After the

pneumoperitoneum was accessed (8–12 mmHg), two trocars with 3 mm or 5 mm were added with the aid of the laparoscopic view. An additional port was inserted in the flank region when needed. After the medialization of the colon, the retroperitoneum was accessed and the ureter, which drained the non-functioning pole, was determined and was detached from the neighbouring tissues with a cautious dissection until the renal hilum. The vessels perfusing the non-functioning pole were cut and ligated with Ligaclip® and the heminephrectomy was finalized with the help of LigaSure® (Fig. 1). Thereafter, the lower part of the ureter of the non-functioning pole was accessed and resected. Hem-o-lok® clips were applied for closure of ureteral stump. The resected renal pole and ureter were removed through the port incision of the navel and the intervention ended after the placement of a drain. The patients were followed postoperatively at the first week, the third and six month, and yearly with clinical examination, ultrasonography (US), dimercaptosuccinic acid (DMSA) scintigraphy, and radiological examination. All intra-operative and postoperative data were recorded. All values were displayed as mean ± standard deviation.

Results

In our study group, 13 of the cases were females and four were males (Table 2). The average age was 55.9±35.8 months (range 8–121). Four patients were below two years of age. Eighteen renal units of the 17 patients with LHNU were affected. In nine patients the upper pole and in nine patients the lower pole was non-functioning. One female patient had bilateral duplex collecting system and the lower poles were affected on both sides. This patient had two LHNUs with a one-month interval between interventions. In all patients, LHNU was carried out with a transperitoneal approach and three or four ports were used in each. Four ports were used in all LHNUs performed in the right kidney. None of the patients needed open surgery. The average duration of the operation was 121.7±24.0 minutes (range 100–200). The average hospitalization time was 1.6±0.4 days (range 1–2 days). Six hours postoperatively, oral nutrition was initiated. For postoperative analgesia, paracetamol (10 mg/kg) was given to all patients. There was no need for narcotic analgesics for any patient. During the operation, major complications, such as bleeding requiring blood transfusion, vessel injury in the normal kidney pole, and colon injury, were not encountered. The average followup period was 29.1±13.4

Table 1. Baseline characteristics of the patients undergoing transperitoneal LHNU

Cases	Gender	Age (months)	Location	Side	Indication	Operative time (minutes)	No. of trocars	Hospitalization time	Complication	Followup (months)	DMSA
Case 1	F	38	Upper pole	Left	UTIs (ectopic ureter)	120	4	2	None	48	(+)
Case 2	M	48	Lower pole	Left	UTIs	120	3	2	None	45	(+)
Case 3	F	39	Upper pole	Left	Incontinence	200	4	2	None	42	(+)
Case 4	F	34	Upper pole	Left	VUR	120	3	2	None	44	(+)
Case 5	F	85	Lower pole	Left	VUR	130	3	1	None	39	(+)
Case 6	F	118	Lower pole Lower pole	Bilateral	VUR and UTIs	120 100	4 3	2	None	40	(+)
Case 7	F	121	Upper pole	Right	Right ureterosel	130	4	2	None	37	(+)
Case 8	F	70	Upper pole	Left	UTIs (ectopic ureter)	150	4	2	None	36	(+)
Case 9	M	47	Lower pole	Right	VUR	120	4	2	None	27	(+)
Case 10	F	60	Lower pole	Right	VUR	120	4	2	None	25	(+)
Case 11	F	82	Lower pole	Left	VUR	110	3	2	None	24	(+)
Case 12	F	22	Lower pole	Left	UTIs and VUR	120	3	2	Pyelonephritis (first month after the operation)	24	(+)
Case 13	F	13	Lower pole	Right	UTIs	100	4	2	None	22	(+)
Case 14	F	8	Upper pole	Left	VUR	100	3	1	None	15	(+)
Case 15	M	35	Upper pole	Left	VUR	110	3	1	None	12	(+)
Case 16	M	108	Upper pole	Right	VUR	100	4	1	None	11	(+)
Case 17	F	23	Upper pole	Left	VUR	100	3	1	None	4	(-)

DMSA: dimercaptosuccinic acid; F: female; LHNU: laparoscopic heminephroureterectomy; M: male; UTI: urinary tract infection; VUR: vesicoureteral reflux.

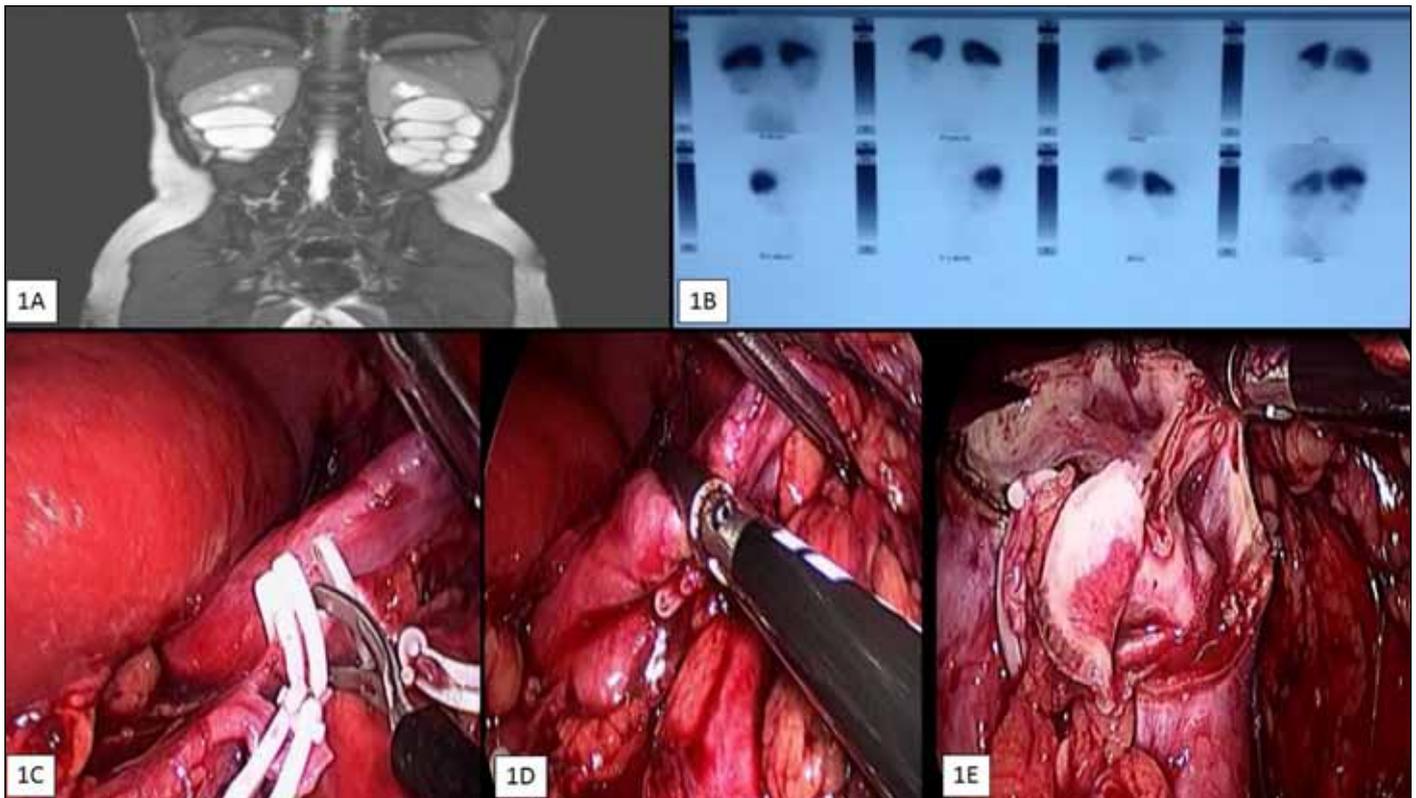


Fig. 1. Transperitoneal laparoscopic heminephroureterectomy in a 10-year-old pediatric patient. (A) and (B) demonstrate the magnetic resonance urography and dimercaptosuccinic acid scan. No function is observed in the lower pole bilaterally; (C–E) demonstrated the surgical steps of the procedure and resection of the lower pole by LigaSure®.

months (range 4–48). As a minor postoperative complication, we had only one case of pyelonephritis in the first month after surgery and this was treated medically. DMSA scintigraphy (6–12 months postoperatively) did not reveal any loss of function during the followup period (DMSA scintigraphy was not performed in the last operated patient).

Discussion

Conventionally, open surgery was preferred for partial nephrectomy carried out in patients with duplex collecting systems. Pediatric urologists believed that LHNU had more advantages in terms of cosmesis, decreased pain, and the minimally invasive nature of the procedure, but they also had concerns about the applicability of nephrectomy performed with the laparoscopic approach.¹⁰ Although laparoscopy has a wide range of use in pediatric urology, LHNU is rather difficult and requires more experience compared with the complete removal of the kidney.¹¹ Heminephroureterectomy (HNU) is a much more complicated intervention than simple nephrectomy due to the occurrence of hematoma as a result of bleeding, urinoma as a result of the urine leakage, and the risk of ischemia in the residual pole, which might occur following the pedicle injury.^{2,12} There were no intraoperative

complications in our study group. The reason might be that the equipment was sufficient and the staff was experienced in pediatric laparoscopic interventions, which involved more than 100 laparoscopic upper tract interventions (such as pyeloplasty, nephrectomy, heminephrectomy, etc.)

In open surgery, secondary atrophy might be seen in the remaining kidney following thrombosis, which occurs in the renal pedicle during the traction downwards and the detachment from the neighbouring tissue in order to expose the renal upper pole. However, there is no such a risk in the laparoscopic surgery because no traction was applied to the renal pedicle.¹² In our study, we did not encounter any problems regarding the renal pedicle during any interventions. During the traditional open approach, a longer or separate incision is generally required for the excision of the distal ureter. However, there is no need for additional incisions with laparoscopic surgery.¹³ All patients in our study group were operated on with the laparoscopic method and open surgery was not required.

Laparoscopic kidney operations might be carried out with the transperitoneal and retroperitoneal approach.^{3,14} The advantages and benefits of these approaches are still under discussion.¹⁴ The surgeons, who preferred the transperitoneal approach suggested that it enabled a larger working space

Table 2. Laparoscopic heminephroureterectomies in children: Literature review

Authors	Mean age surgery, (mos)	Gender		Total pts	Affected side		Renal pole		Method	Mean operative time (mins)	Operative time (range) (mins)	Conversion to open procedure	Complications	Re-operation	Average LOS (days)	Port	Followup (months)	Median and range
		F	M		Rt	Lt	Upper	Lower										
Our series	55.9	13	4	17	6	12	9	9	18	-	121.7	0	1/18 (5.5%)	0	1.6	3 or 4	29.1 (4-48)	
Esposito et al ² (2015)	61	32	20	52	15	37	42	10	52	-	166	0	10/52 (19.2%)	0	3.5	3 or 4	30 (12-60)	
Cabezali et al ¹⁸ (2013)	18	14	14	28	16	12	19	9	28	-	137	0	20/28 (71.4%)	0	2.7	3 or 4	38.4	
Dingemann et al ¹⁹ (2013)	26.4	16	6	22	10	12	20	2	22	-	173	0	8/22 (36.3%)	1	3.6	3 or 4	62.9	
Nerli et al ³ (2011)	29	21	8	29	NR	NR	NR	NR	29	-	94	0	4/29 (13.7%)	0	3	3	20 (7-48)	
Jayram et al ²⁰ (2011)	11.4	52	90	142	NR	NR	113	29	-	142	120	11 (7.7%)	8/142 (5.6%)	0	2	3 or 4	54 (7-201)	
Schneider et al ¹⁶ (2010)	9.1	5	5	10	3	7	7	3	10	-	123	0	4/10 (40%)	0	2.9	3	13.1	
Singh et al ¹⁷ (2010)	43	32	10	42	NR	NR	31	10	-	42	90	1/42 (2.4%)	2/42 (4.7%)	0	3	3	11 (1-15)	
You et al ¹¹ (2010)	28	14	3	17	5	13	12	6	17	1	167	0	2/17 (11.7%)	0	NR	3 or 4	22.9 (1-55)	
Leclair et al ⁵ (2009)	8.6	29	19	48	18	30	36	12	-	48	120	10/48 (21%)	2/48 (4.1%)	0	3	3 or 4	14 (3-125)	
Chertin et al ¹⁰ (2007)	43	6	4	10	3	7	5	5	10	-	NR	1/10 (10%)	1/10 (10%)	0	2.7	3	28 (6-81)	
Mushtaq et al ²¹ (2007)	14	34	14	48	25	29	44	10	-	54	105	0	4/48 (8.3%)	0	2	3	22 (3-57)	
Piaggio et al ⁴ (2006)	18	10	4	14	8	6	11	3	14	-	180	0	2/14 (8.3%)	0	2	3	NR	
Castellan et al ⁷ (2006)	49	35	13	48	NR	NR	44	4	32	16	130	2/48 (4.1%)	5/48 (10.4%)	0	2.5	3	42.4 (9-87)	
Metzelder et al ⁶ (2006)	31	5	2	7	NR	NR	6	1	7	1	144	0	0	0	3.7	3 or 4	3	
Wallis et al ¹⁵ (2006)	60	21	5	26	NR	NR	18	5	-	26	174	4/26 (15.3%)	4/22 (18.1%)	0	2.2	3	33 (3-56)	
Valla et al ¹² (2003)	22	15	9	24	NR	NR	24	-	-	24	160	3/24 (12.5%)	14/24 (58.3%)	1	3.4	3 or 4	32 (6-60)	
Horowitz et al ²² (2001)	45	8	5	13	7	7	14	-	14	-	100	0	1/13 (7.7%)	0	2.6	3 or 4	NR	
Janetschek et al ¹³ (1997)	65	7	7	14	NR	NR	9	5	14	-	222	0	0	0	4.4	4	NR	

F: female; LOS: length of stay; Lt: left; M: male; NR: not reported; RP: retroperitoneal; Rt: right; TP: transperitoneal.

and that they were oriented to the anatomical structures much more naturally. The reason the surgeons preferred the retroperitoneal approach was to prevent postoperative intestinal injuries and adhesions. However, with this technique, it is difficult to obtain a sufficiently large working space to access the upper renal pole and the distal ureter and to control the renal hilus.¹⁴ Although postoperative adhesions might emerge in the transperitoneal approach, studies confirmed that they had no significance.¹⁴ Furthermore, as the peritoneum is fragile in children,¹² there is also a risk of the intestinal injury in the retroperitoneal approach.^{5,14} Studies did not demonstrate any significant difference between the transperitoneal laparoscopic and retroperitoneal approach regarding the complications, need for postoperative analgesics, and hospitalization time.¹⁴ In the available literature, comparisons of the transperitoneal and retroperitoneal LHNU did not reveal any proof for the superiority of either of these approaches in respect to major complications.² However, it is believed that the transperitoneal approach is important in children under two years of age for the decrease of severe complications and for the conversion to open surgery.^{15,16} Castellan et al⁷ reported that in their study of 48 cases operated with the transperitoneal and retroperitoneal approach, four of the total five complications emerged in children younger than one year. In two cases, the intervention was started with the retroperitoneal approach, but was then converted to open surgery.⁷

In the transperitoneal approach, the renal upper pole is easier to access and it is less risky for the normal lower renal pole. Contrarily, in the retroperitoneal approach, the working place is smaller and it is riskier for the normal lower renal pole.¹⁴ Additionally, in some studies conducted with the retroperitoneal LHNU technique, severe complications and conversion to the open surgery were reported. For example, Wallis et al showed a complication rate of 9.1%, and the rate of conversion to open surgery was 14.8%.¹⁵ In a study by Valla et al, the rate of the conversion to open surgery was 12.5%.¹² In our study, all patients were operated with the transperitoneal LHNU. None of our patients had severe (such as injury to the normal renal pole, postoperative ileus) or minor complications (such as urinary leakage or fever).

LHNU is usually carried out with three or four ports.^{2,11,13,14} In the LHNU operations of the right kidney, liver retraction and the use of the third working port to enable colon retraction in children over 3 kg was recommended.⁸ Taking the differences of both left and right sides into consideration, it is useful to insert the fourth trocar on the right side for the liver retraction and for better exposure of the upper side of the kidney. Usage of the fourth trocar on the left side depends on the size of the spleen and on the preference of the surgeon. For pediatric urologists who are unexperienced in these operations, usage of four ports in LHNUs was recommended for both right and left sides.² In our study group,

we completed the interventions with a total of four ports (one was a camera) on the right LHNU interventions and usually with three ports on left LHNU interventions (in some cases we used four ports for left LHNU).

Janetschek et al¹³ suggested that the preoperative insertion of a stent to any of the ureters in the pole of the affected or normal kidney was not necessary to distinguish the ureters. On the other hand, some authors recommend the insertion of a stent to the ureter of the pole of the affected kidney, as it makes it easier to distinguish it from the normal ureter during laparoscopy.¹¹ In our cases, we inserted a ureteral catheter to the ureter of the pole of the normal kidney through cystoscopy. Operations can be carried out much more safely and quickly with the guidance of a catheter inserted into the ureter of the pole to any affected or injured kidney.

Another key point in our technique was using a LigaSure during the resection of the affected pole of the kidney. This allows the surgeon to make a delicate resection of the paranchyma without causing any harm to the normal pole. In addition, it prevents any unnecessary bleeding due to coagulation property of the instrument at the same time as resection.

Referring to their study group, Castellan et al reported there was no difference between the durations of the LHNU operations carried out with the transperitoneal or retroperitoneal approach (125 and 133 minutes, respectively).⁷ The average duration of the LHNU, which was 222 minutes (range 180–330) in the last 20 years,¹³ dropped to 90 minutes (range 45–150)^{3,17} in both transperitoneal or retroperitoneal methods in recent years. As the average duration of open surgery in HNU is 113.5 minutes,¹⁷ the laparoscopic HNU has obvious advantages over open surgery, also with respect to the duration of the intervention. In our study group, the recorded average duration of the operation, including cystoscopy and retrograde pyelography, was 121.7±24.0 minutes (range 100–200).

LHNU has the advantage of shorter hospitalization time, lower morbidity, lower complication rates, and more satisfying cosmetic results compared with open surgery.^{2,7,8,11,13} In the studies conducted with age-matched cohort groups, it was found that the hospitalization time was shorter in LHNU carried out with transperitoneal or retroperitoneal approach compared with open surgery.¹¹ In their study, Chertin et al noticed the significantly different average hospitalization times between open surgery and LHNU (2.7 and 5.1 days, respectively).¹⁰ In our study group, the average hospitalization time was 1.6±0.4 days (range 1–2). This result was in line with the results reported by other LHNU study groups (2–4.4 days in both transperitoneal and retroperitoneal methods) (Table 1).

Conclusion

We conclude that transperitoneal LHNU might be preferred over open surgery for pediatric patients in all age groups

in centres with surgeons experienced in laparoscopy and with specialized equipment, particularly when considering operation time, cosmetic results, minimal need for the post-operative analgesics, minimal complication rates, shorter hospitalization time, and quicker return to normal life.

Competing interests: The authors report no competing personal or financial interests.

This paper has been peer-reviewed.

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