Transperitoneal laparoscopic heminephroureterectomy in 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 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 nonfunctioning 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 usage 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 usage remained limited.[2] LHNU can be performed with transabdominal (transperitoneal), lateral retroperitoneoscopic and posterior retroperitoneoscopic approach.[3,6,7] In addition, robotic-assisted approach is also described in the literature.[1] The advantages of using transperitoneal laparoscopic approach are; 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 4 males - 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 follow-ups 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 3F 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 (5mm) was inserted through the upper side of the umbilicus with the Hasson method. After the pneumoperitoneum was accessed (8-12mmHg), two trocars with 3mm or 5mm 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 nonfunctioning pole, was determined and was detached from the neighboring tissues with a cautious dissection until the renal hilum. The vessels perfusing the nonfunctioning pole were cut and ligated with Ligaclip® and the heminephrectomy was finalized with the help of LigaSure® (Figure 1). Thereafter, the lower part of the ureter of the nonfunctioning 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 1st week, the 3rd and 6th month, and yearly with clinical examination, ultrasonography (USG), dimercaptosuccinic acid (DMSA) scintigraphy and radiological examination. All

intraoperative 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 4 were males (Table 2). The average age was 55.9±35.8 months (8-121 months). Four patients were below 2 years of age. Eighteen renal units of the 17 patients with LHNU were affected. In 9 patients the upper pole and in 9 patients the lower pole was nonfunctioning. One female patient had bilateral duplex collecting system and the lower poles were affected on both sides. This patient had two LHNUs with 1 month interval between the interventions. In all patients, LHNU was carried out with a transperitoneal approach and 3 or 4 ports were used in each patient. 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 measured as 121.7±24.0 minutes (100-200 minutes). The average hospitalization time was 1.6±0.4 days (1-2 days). Six hours postoperatively oral nutrition was initiated. For postoperative analgesia, paracetamol (10mg/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 follow-up period was 29.1±13.4 months (4-48 months). 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 follow-up 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 intra operative complications in our study group. The reason might be that the equipment was sufficient and the staff were 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 neighboring tissue in order to expose the renal upper pole. However, there is not 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 all 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 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 the hospitalization time.[14] In the available literature, comparisons of the transperitoneal and retroperitoneal LHNU did not reveal any proof for the superiority of any of these approaches in respect of major complications.[2] However, it is believed that the transperitoneal approach is important in children below 2 years of age for the decrease of severe complications and for the conversion to open surgery.[15,16] Castellan et al[7] reported that in their study group of 48 cases, who were operated with the transperitoneal and retroperitoneal approach, 4 of the total 5 complications emerged in children with an age below 1 year. In two cases, the intervention was started with the retroperitoneal approach, but then was 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, in the study of Wallis et al., the complication rate was 9.1% and the rate of conversion to open surgery was 14.8%. In the study of Valla et al, the rate of the conversion to open surgery was 12.5%.[11] In our study group, all patients were operated with the transperitoneal LHNU. None of our patients had severe complications 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 3 or 4 ports.[2,11,13,14] In the LHNU operations of the right kidney, liver retraction and the use of the 3rd 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 4th trocar on the right side for the liver retraction and for better exposure of the upper side of the kidney. Usage of the 4th 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 4 ports in LHNUs was recommended for both right and left sides.[2] In our study group, we completed the interventions with a total of 4 ports (one was a camera) on the right LHNU interventions and usually with 3 ports on left LHNU interventions (only in some cases we used 4 ports). Janetschek et al.[13] 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 other authors recommended the insertion of a stent to the ureter of the pole of the affected kidney as it made it easier to distinguish it from the normal ureter during laparoscopy.[11] Following the same idea, in our cases, we inserted through cystoscopy a ureteral catheter to the ureter of the pole of the normal kidney (not of the affected kidney). Operations can be carried out much safer and faster 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 from unnecessary bleeding due to coagulation property of the instrument at the same time of the resection.

Referring to their study group, Castellan et al. reported that 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 (180-330 minutes) in the last 20 years,[13] dropped to 90 minutes (45-150 minutes)[3,20] in both transperitoneal or retroperitoneal methods in recent years. As the average duration of open surgery in HNU is 113.5 minutes,[20] the laparoscopic HNU has obvious advantages over open surgery also in respect of 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 (100-200 minutes). LHNU has the advantages 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 out that the hospitalization time was shorter in LHNU carried out with transperitoneal or retroperitoneal approach compared with open surgery.[11] In their study, Boris 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 calculated as 1.6±0.4 days (1–2 days). 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 for pediatric patients in all age groups in centers with surgeons experienced in laparoscopy and with specialized equipment, when considering the operation time comparable to open surgery, perfect cosmetic results, minimal need for the postoperative analgesics, minimal complication rates, short hospitalization time and fast return to normal life of both the child and his or her family.

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Figures and Tables

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

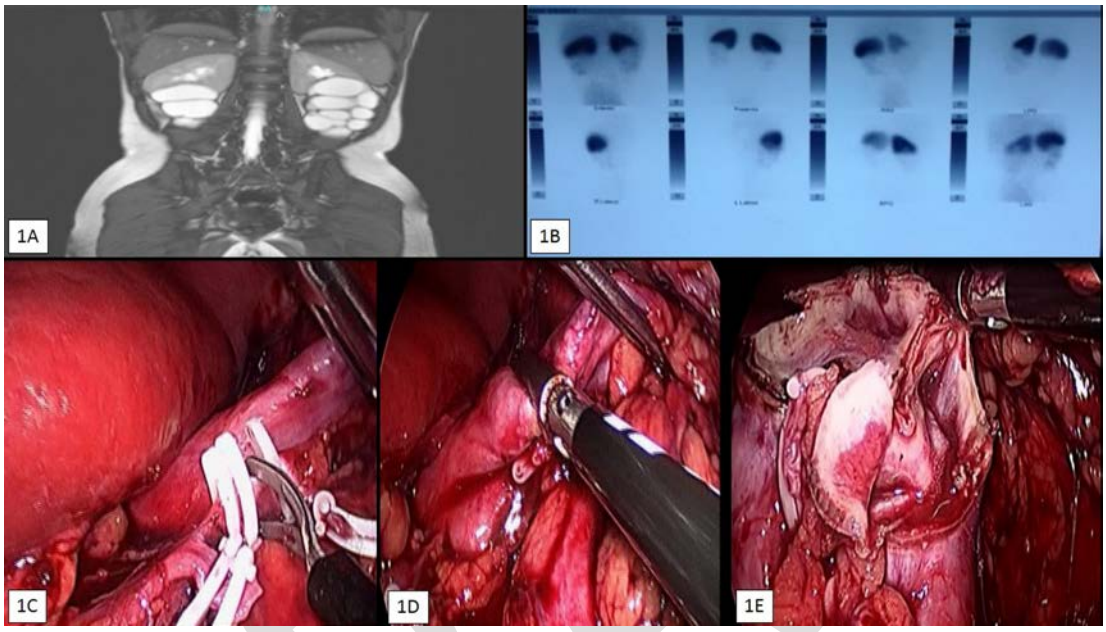

Table 1. Baseline characteristics of the patients undergoing transperitoneal LHNU

Cases	Gender	Age (months)	Location	Side	Indication	Operative time (minutes)	No. of trocars	Hospi-talization time	Compli-cation	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	Bi-lateral	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	(-)

F: female; M: male; UTI: urinary tract infection;VUR:

Authors	Mean age (mos)	Age at surgery, range (mos)	Gender		Sum of pts	Affected side		Renal pole		Method		Mean operative time	Operative time (range)	Conversion to open procedure	Complications	Re-operation	Average LOS (days)	Port	Follow-up (months)
			F	M		Rt	Lt	Upper	Lower	TP	RP	(mins)	(mins)						Median and range
Our series	55.9	8–121	13	4	17	6	12	9	9	18	-	121.7	100–200	0	1/18 (5.5%)	0	1.6	3 or 4	29.1 (4-48)
Espesito et al[2] 2015	61	6–115	32	20	52	15	37	42	10	52	-	166	70–215	0	10/52 (19.2%)	0	3.5	3 or 4	30 (12-60)
Cabezali et al[17] 2013	18	3–70	14	14	28	16	12	19	9	28	-	137	90–200	0	20/28(71.4%)	0	2.7	3 or 4	38.4
Dingemann et al[18] 2013	26.4	3–128	16	6	22	10	12	20	2	22	-	173	81–265	0	8/22 (36.3%)	1	3.6	3 or 4	62.9
Nerli et al[3] 2011	29	3–192	21	8	29	NR	NR	NR	NR	29	-	94	68–146	0	4/29 (13.7%)	0	3	3	20 (7-48)
Jayram et al[19] 2011	11.4	1–145	52	90	142	NR	NR	113	29	-	142	120	60–230	11 (7.7%)	8/142 (5.6%)	0	2	3 or 4	54 (7-201)
Schneider et al[16] 2010	9.1	3.5–20.4	5	5	10	3	7	7	3	10	-	123	90–195	0	4/10 (40%)	0	2.9	3	13.1
Singh et al[20] 2010	43	4–166	32	10	42	NR	NR	31	10	-	42	90	45–150	1/42 (2.4%)	2/42 (4.7%)	0	3	3	11 (1-15)
You et al[11] 2010	28	3–110	14	3	17	5	13	12	6	17	1	167	98–250	0	2/17 (11.7%)	0	NR	3 or 4	22.9 (1-55)
Leclair et al[5] 2009	8.6	1.5–89	29	19	48	18	30	36	12	-	48	120	70–215	10/48 (21%)	2/48 (4.1%)	0	3	3 or 4	14 (3-125)
Chertin et al[10] 2007	43	NR	6	4	10	3	7	5	5	10	-	NR	NR	1/10 (10%)	1/10 (10%)	0	2.7	3	28 (6-81)
Mushtaq et	14	2–112	34	14	48	25	29	44	10	-	54	105	50–150	0	4/48 (8.3%)	0	2	3	22 (3-57)

al[21] 2007																		
Piaggio et al[4] 2006	18	4.1–160	10	4	14	8	6	11	3	14	-	180	81–349	0	2/14 (8.3%)	0	2	3	NR
Castellan et al[7] 2006	49	1.5–204	35	13	48	NR	NR	44	4	32	16	130	80–180	2/48 (4.1%)	5/48 (10.4%)	0	2.5	3	42.4 (9-87)
Metzelder et al[6] 2006	31	6–85	5	2	7	NR	NR	6	1	7	1	144	90–210	0	0	0	3.7	3 or 4	3
Wallis et al[15] 2006	60	4–216	21	5	26	NR	NR	18	5	-	26	174	105–300	4/26 (15.3%)	4/22 (18.1%)	0	2.2	3	33 (3-56)
Valla et al[12] 2003	22	1–84	15	9	24	NR	NR	24	-	-	24	160	NR	3/24 (12.5%)	14/24 (58.3%)	1	3.4	3 or 4	32 (6-60)
Horowitz et al[22] 2001	45	5–168	8	5	13	7	7	14	-	14	-	100	70–135	0	1/13 (7.7%)	0	2.6	3 or 4	NR
Janetschek et al[13] 1997	65	7-–168	7	7	14	NR	NR	9	5	14	-	222	180–330	0	0	0	4.4	4	NR