



Lich-Gregoir vesico-ureteral reimplantation for duplex kidney anomalies in the pediatric population: a retrospective cohort study between laparoscopic and open surgery

Xiaojiang Zhu^{1#}, Jun Wang^{1#}, Haobo Zhu^{1#}, Liqu Huang¹, Chenjun Chen¹, Lixia Wang¹, Jun Dong¹, Zheng Ge¹, Geng Ma¹, Yunfei Guo¹, Songming Huang²

¹Department of Urology, Children's Hospital of Nanjing Medical University, Nanjing, China; ²Department of Nephrology, Children's Hospital of Nanjing Medical University, Nanjing, China

Contributions: (I) Conception and design: X Zhu, J Wang, Y Guo, S Huang; (II) Administrative support: Y Guo, S Huang; (III) Provision of study materials or patients: H Zhu, L Huang, J Dong; (IV) Collection and assembly of data: J Wang, Z Ge; (V) Data analysis and interpretation: X Zhu, C Chen, G Ma; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

[#]These authors contributed equally to this work.

Correspondence to: Songming Huang. Department of Nephrology, Children's Hospital of Nanjing Medical University, Nanjing, China. Email: chinachangzhou@126.com; Yunfei Guo. Department of Urology, Children's Hospital of Nanjing Medical University, Nanjing, China. Email: guoyunfei_nj@163.com.

Background: The aim of the study is to compare the Lich-Gregoir vesico-ureteral reimplantation in laparoscopy and open surgery.

Methods: In this case control study, we enrolled pediatric patients who were diagnosed with unilateral duplex kidney and had underwent surgical treatment. The surgical treatments were either conventional open surgery or laparoscopic surgery. We collected the basic demographic data and extracted the operative-related statistics such as operation time, blood loss, length of hospital stay, pain level, and post-operative complications. The two groups were compared using Student's *t*-test.

Results: A total of 90 subjects were enrolled. Of the enrolled subjects, 35 underwent open surgery and 55 underwent laparoscopic surgery. There were no observable difference in the basic demographics between two groups ($P > 0.05$). The duration of operation in laparoscopic surgery group was significantly shorter than in the open surgery group (95.60 ± 5.25 vs. 108.70 ± 3.12 min, $P = 0.040$). It was also noted that the amount of blood loss, length of hospital stay, drainage level, and the mean visual analog scale in laparoscopic group were significantly lower ($P < 0.05$). The total incidence of complications in the laparoscopic and open surgery groups were 16.36% and 37.14%, respectively.

Conclusions: Laparoscopic Lich-Gregoir vesico-ureteral reimplantation surgery management can be successful, clinically effective, and safe for pediatric population with functional duplex kidneys, and is better than the open surgery techniques.

Keywords: Lich-Gregoir procedures; laparoscopic; duplex kidney; vesico-ureteral reimplantation; pediatrics

Submitted Jun 17, 2020. Accepted for publication Nov 30, 2020.

doi: 10.21037/tp-20-163

View this article at: <http://dx.doi.org/10.21037/tp-20-163>

Introduction

Duplex kidney is a common congenital abnormality of the urinary system in the pediatric population. Its incidence is 1% worldwide (1,2). Most cases of duplex kidneys

become apparent in childhood with classic symptoms that signify the disease. Such symptoms include incontinence, recurrent urinary tract infections (UTIs) and ureteropelvic junction obstruction (3,4). For patients with duplex kidneys

and ectopic opening of ureter complicated by leakage, obstruction and/or severe vesico-ureteral reflux (VUR), vesico-ureteral reimplantation is considered to be the optimal therapy instead of heminephrectomy (5).

For a long time, open surgery was considered as the conventional surgical treatment for pediatric patients with duplex kidney. But in recent years, laparoscopy has been gaining significant acceptance in pediatric urology (6,7). Minimally invasive procedures such as laparoscopy and endoscopic injection have demonstrated relatively equivalent short-term and long-term outcomes with reduced complications and rapid rehabilitation in both adult and pediatric patients when compared to open surgery (8,9). With the incorporation of new technical advances, the laparoscopic vesico-ureteral reimplantation has been gradually incorporated into the management of patients with duplex kidney abnormalities. Conventional vesico-ureteral reimplantation can be divided into three categories: extra-vesical, intra-vesical and union of Intra- and extra-vesical approaches (10). Among various intra-vesical approaches, Cohen and Politano-Leadbetter methods are the most widely accepted and applied in clinical practice (11,12). However, Lich-Gregoir procedure is recommended for ureteral obstruction, VUR and ectopic opening of ureter treatment because it causes less damage to patients, is associated with handy skills, and guarantees shorter hospital stays, (13,14). Our treatment center relies on both open surgery and laparoscopic surgery to treat pediatric duplex kidney using the Lich-Gregoir procedure. This is due to the easier access granted by the open Lich-Gregoir vesico-ureteral reimplantation for younger surgeons as well as the higher success rate of open surgery in previous reports. Since the minimal surgical techniques have attractive advantages for pediatric patients, it was expedient to compare open and laparoscopic surgery using the Lich-Gregoir vesico-ureteral reimplantation in pediatric patients in our center.

Therefore, the aim of this study is to retrospectively investigate the clinical efficacy and safety of laparoscopic Lich-Gregoir vesico-ureteral reimplantation on pediatric patients diagnosed with duplex kidneys when compared to conventional open surgery. We present the following article in accordance with the STROBE reporting checklist (available at <http://dx.doi.org/10.21037/tp-20-162>).

Methods

Study population

This study was conducted as a retrospective 6-month

study and case-control study. We considered pediatric patients admitted into our center (Department of Urology, The Affiliated Children's Hospital of Nanjing Medical University) from Jan 1st, 2015 to Jan 1st, 2018 for assessment. Our study has been reported in line with the STROCSS criteria (15). We presented the assessment criteria as follows: (I) patients had to be between 6 months and 18 years of age at the time of surgery; (II) patients had to be diagnosed with unilateral duplex kidney using Doppler B ultrasound, intravenous pyelography, abdominal computer tomography (CT), magnetic resonance urography (MRU) or Retrograde cystoscopy; (III) all duplex kidneys had to be confirmed to be functional using retrograde cystoscopy; (IV) patients' legal guardians had to be willing to participate in the study.

Data extraction

Outpatient and inpatient records for each individual patient in our study were extracted and reviewed by two independent authors (XJ Zhu and J Wang). Any disagreements were resolved either by discussion or by inviting a third reviewer (YF Guo). Basic demographic data analyzed included gender, age, weight, side of duplex kidneys, renal function, complications of duplex kidneys, radiological images (ureters and bladder ultrasonography, intravenous pyelography, CT and MRU), operative records (operative time, hospital stay, blood loss) and post-operative complications.

Surgical techniques

Laparoscopic Lich-Gregoir vesico-ureteral reimplantation surgery was performed with tracheal intubation with aspiration. All patients underwent cystoscopy with the ureteral intubation before laparoscopic surgery. The patients were placed in the supine position and put under general anesthesia. Pneumoperitoneum was created with a Veress needle and 5 mm Trocars were placed in the manipura, the right and left margin of rectus abdominis respectively. The distal portion of duplex ureter was dissected and clipped. The section of overdistension or stricture in the proximal ureter was resected to create an appropriate ureter tube. The myometrium and mucous layer of rear bladder side wall was cut to a 1 cm size. Subsequently, the cut ureteral opening was anastomosed to the bladder mucosa, and the double-J stent was placed before closing the anastomosis. The double-J stent was then removed by cystoscopy after 1–1.5 months post-surgery.

Open surgery was performed in line with the conventional procedures (16,17). A Pfannenstiel incision was made and flanked to the outer edge of the rectus abdominis to the aponeurosis of the external oblique muscle. The ureter was defined at iliac vein level and dissection was continued through ureterovesical junction until the stenosis section was identified. The strictured ureteral segment was clipped and the proximal section was spatulated. A submucosal tunnel was created and the mucosa detached from the distal end of tunnel. Then, a double-J stent was placed before performing the final suture. Drainage strips were removed after 1–2 days following the operation and the catheter was removed after 7–9 days.

Outcomes

The primary outcome for consideration in this study was the operation time, while the intraoperative and perioperative variables, including blood loss, the length of hospital stay, drainage level, and visual analog scale (VAS) score, were the secondary outcomes. In addition, the postoperative complications were also included in the secondary outcomes. Evaluation was performed to assess severity of pain declared by the patient. In the interpretation of the VAS scores, 10 represented maximum pain and 0 represented no pain (18).

Statistical analysis

The continuous variables were presented as mean \pm standard deviation (SD). The Student's *t*-test was used for the comparison of the mean age and operation-related statistics and a *P* value less than 0.05 was considered to be statistically significant. The statistical analysis was done using the SPSS software (Version 16.0, IBM Corp., Armonk, NY, USA).

Ethical Statement

The study protocol was in accordance with the ethical standards of the Declarations of Helsinki and Istanbul as revised in 2013. This research was approved by the local Ethics Committee of Nanjing Medical University Affiliated Nanjing Children's Hospital (No. 201801172-1). Written informed consent was obtained from all parents of included children.

Results

We enrolled a total of 90 pediatric patients in our study after

performing the eligibility assessment in accordance with the inclusion criteria. The case numbers of open surgery and laparoscopic groups were 35 and 55 respectively. The baseline patient demographic data of patients enrolled were as shown in *Table 1*. There was no observable significant difference in the basic characteristics of participants between the two groups.

All the procedures were completed without intraoperative complications and no conversion to open surgery in the laparoscopic group was performed. Operative time was significantly shorter statistically during laparoscopic surgery compared to open surgery (95.60 ± 5.25 vs. 108.70 ± 3.12 min, $P=0.040$; *Table 2*). When compared with the open surgery group, the amount of blood loss in laparoscopic group was significantly reduced and the length of hospital stay was also shortened (Blood loss: 11.40 ± 1.14 vs. 44.10 ± 4.112 mL, $P<0.0001$; Hospital stay: 2.30 ± 0.34 vs. 7.50 ± 0.60 days, $P<0.0001$; *Table 2*). Moreover, the drainage level was significantly decreased with the use of laparoscopic surgery (15.10 ± 1.82 vs. 23.70 ± 1.45 mL, $P=0.0016$; *Table 2*). At six hours postoperation, the mean VAS score was 4.69 ± 0.52 in laparoscopic group and 6.63 ± 0.46 in open surgery group ($P=0.0089$). Afterward, the mean VAS score at post-operative day 1 was 3.38 ± 0.44 in laparoscopic group. This was significantly lower than in open surgery group (3.38 ± 0.44 vs. 4.25 ± 0.41 , $P=0.0016$; *Table 2*).

Postoperative complications were as summarized in *Table 3*. For the two groups, the total incidences of complications were 16.36% in laparoscopic group and 37.14% in open group ($P=0.025$). Most complications resolved spontaneously or after medical therapy without the need to perform a new surgical procedure. One exception for this was one case in the open surgery group where an intervention was required to correct urinary retention.

Discussion

Both laparoscopic and open surgery methods of heminephroureterectomy are well-recognized for the treatment of duplex kidney anomalies in the pediatric population (19). However, we attempted to combine the Lich-Gregoir vesico-ureteral reimplantation surgery with the laparoscopic techniques for functional duplex kidneys. It gave us a chance to explore the clinical efficacy and safety of the procedure. In this study, we found out that using the laparoscopic surgery and the Lich-Gregoir vesico-ureteral reimplantation surgery method provided favorable and substantial value to the pediatric patients with functional

Table 1 Basic demographics of eligible pediatric patients in this study

Variables	Open	Laparoscopic	P value
Case number	35	55	
Mean age (months; mean \pm SD)	20.78 \pm 3.38	21.44 \pm 3.70	0.90
Gender (boys/girls)	25/10	32/23	0.21
Mean weight (kg; mean \pm SD)	16.89 \pm 2.58	15.67 \pm 3.37	0.78
Side (left/right)	20/15	35/20	0.54
Serum creatinine (μ mol/L; mean \pm SD)	59.00 \pm 2.74	57.56 \pm 2.55	0.70
Serum BUN (mmol/L; mean \pm SD)	4.82 \pm 0.35	5.08 \pm 0.31	0.59
Symptoms, n (%)			
Lumbar pain	10 (28.57)	15 (27.27)	0.89
Recurrent UTI	5 (14.29)	6 (10.91)	0.63
Urinary incontinence	4 (11.43)	7 (12.73)	0.85
Hydronephrosis	8 (22.86)	12 (21.82)	0.91
Complications, n (%)			0.78
Ureterocele	15 (42.86)	27 (49.09)	
Ectopic to urethra	9 (25.71)	11 (20.00)	
Reflux	11 (31.43)	17 (30.91)	

SD, standard deviations; BUN, blood urine nitrogen; UTI, urinary tract infection.

Table 2 Outcomes of Lich-Gregoir vesico-ureteral reimplantation surgery in open and laparoscopic groups

Variables	Open	Laparoscopic	P value
Operation time (min; mean \pm SD)	108.70 \pm 3.12	95.60 \pm 5.25	0.040
Blood loss (mL; mean \pm SD)	44.10 \pm 4.11	11.40 \pm 1.14	<0.0001
Hospital stay (days; mean \pm SD)	7.50 \pm 0.60	2.30 \pm 0.34	<0.0001
Drainage level (mL; mean \pm SD)	23.70 \pm 1.45	15.10 \pm 1.82	0.0016
VAS Day 0 (mean \pm SD)	6.63 \pm 0.46	4.69 \pm 0.52	0.0089
VAS Day 1 (mean \pm SD)	4.25 \pm 0.41	3.38 \pm 0.44	0.0016

SD, standard deviations; VAS, visual analog scale.

duplex kidneys, except for longer operative time. No significant complications were observed when compared to the conventional open surgery.

Open surgical procedures have good long-term outcomes with a reported success rate of more than 80% (20). Nevertheless, longer hospital stays, extra blood loss and additional pain management are the common downsides of this procedure. This does not provide convenient outcomes for the pediatric population (16) hence, the need for minimally invasive techniques, such as laparoscopic

procedures in pediatric urology. In this study, we also made significant findings in the similar clinical outcomes after comparing open and laparoscopic surgeries. These included longer hospital stays, higher amount of blood loss, extra drainage level and additional pain. These findings were consistent with previous reports, suggesting laparoscopic Lich-Gregoir vesico-ureteral reimplantation procedures are preferable for the treatment of functional duplex kidneys. As Ehrlich *et al.* (21) reported, the first case of laparoscopic Lich-Gregoir surgery for the treatment of pediatric VUR

Table 3 Postoperative complications in open and laparoscopic group

Variables	Open (n=35)	Laparoscopic (n=55)
All complications	13 (37.14)	9 (16.36)
Fever	2 (5.71)	1 (1.82)
UTIs	3 (8.57)	2 (3.64)
Bleeding	1 (2.86)	1 (1.82)
Urinary retention	1 (2.86)	0 (0)
Nausea/vomiting	2 (5.71)	2 (3.64)
Reoperation	1 (2.86)	0 (0)
Persistent hematuria	1 (2.86)	1 (1.82)
Reflux persistence	2 (5.71)	2 (3.64)

UTIs, urinary tract infections.

was performed in 1994. But there has been an increase in the application of the laparoscopic Lich-Gregoir procedures in recent years. During our single-center experience, we noticed that the laparoscopic Lich-Gregoir procedures were highly indicated for the VUR cases with Grade III or IV, as well as for the Grade V VUR cases without distal ureteral distortion or over-distension. Additionally, we routinely performed the cystoscopy with the ureteral intubation for patients with ectopic ureter opening to distinguish the normal from duplex ureter during laparoscopic Lich-Gregoir procedures.

It was also found that longer operative time in laparoscopic Lich-Gregoir procedures can be associated with several factors. First, as mentioned above, a cystoscopy for the incubation of ureteral catheter was routinely performed to distinguish the normal and duplex ureter. This inevitably prolonged the operative time of laparoscopic surgery. Then, the ureteral suture tended to a difficult and time-consuming process during the procedures. Besides, the adnexa uteri always affected the exposure of surgical visual field in the process of laparoscopic Lich-Gregoir procedures for girls. Dissection of adnexa uteri would be performed, contributing to the additional operative time. Although the operative time was significantly longer in laparoscopic procedures, the extra operative time was still acceptable regarding the pronounced advantages. The advantages included smaller bleeding amount, lower post-operative pain levels, and shorter hospital stays.

Rate of complications reported for laparoscopic surgery in our study was favorable and significant. Most of the complications were mild to moderate and included fever,

UTIs and gastroenteric reactions. One of the most common complications observed after reconstructive ureteric surgery is recurrent stenosis. It has an incidence of approximately 5% (22). In our study, we reported 2 cases (5.71%) of urinary reflux in open surgery group and 2 cases (3.64%) in laparoscopic group, owing to the post-operative ureteral stenosis which was consistent with the reported statistics. Therefore, our study indicated that the laparoscopic Lich-Gregoir procedure for vesico-ureteral reimplantation is evidently safe for pediatric patients.

We noticed some limitations in our study. First, this was a retrospective study without more evidential design. Our follow-up duration for this study was 6 months, a relatively short-term duration to compare open surgery and laparoscopic groups. The long-term outcomes should still be followed to confirm the efficacy and safety of the procedures.

In conclusion, the management of duplex kidney anomalies using laparoscopic Lich-Gregoir vesico-ureteral reimplantation surgery can be successful, clinically effective and safe for pediatric population and the procedure is way more advantageous than open surgery techniques.

Acknowledgments

Funding: None.

Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at <http://dx.doi.org>

[org/10.21037/tp-20-162](https://doi.org/10.21037/tp-20-162)

Data Sharing Statement: Available at <http://dx.doi.org/10.21037/tp-20-162>

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at: <http://dx.doi.org/10.21037/tp-20-162>). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study protocol was in accordance with the ethical standards of the Declarations of Helsinki and Istanbul as revised in 2013. This research was approved by the local Ethics Committee of Nanjing Medical University Affiliated Nanjing Children's Hospital (No. 201801172-1). Written informed consent was obtained from all parents of included children.

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Cite this article as: Zhu X, Wang J, Zhu H, Huang L, Chen C, Wang L, Dong J, Ge Z, Ma G, Guo Y, Huang S. Lich-Gregoir vesico-ureteral reimplantation for duplex kidney anomalies in the pediatric population: a retrospective cohort study between laparoscopic and open surgery. *Transl Pediatr* 2021;10(1):26-32. doi: 10.21037/tp-20-163

Table S1 Demographic and other baseline information of the children with CHD

Indicator	N (mean ± SD)	Normal blood coagulation	Abnormal blood coagulation
Sex (M/F)	1,690 (941/749)	497 (50.35%)/490 (49.65%)	444 (63.16%)/259 (36.84%)
Age	1,690 (1.751±2.731)	987 (2.555±3.132)	703 (0.623±1.405)
PT	471 (11.221±0.664)	415 (11.110±0.658)	56 (11.202±0.709)
APTT	471 (34.655±2.805)	415 (34.692±2.790)	56 (34.382±2.927)
INR	471 (0.974±0.056)	415 (0.973±0.056)	56 (0.983±0.063)
FBG	471 (2.497±0.408)	415 (2.499±0.402)	56 (2.480±0.457)
WBC	1,378 (10.291±5.107)	845 (9.643±4.732)	533 (11.318±5.501)
PLT	1,109 (328.318±145.780)	678 (324.153±133.130)	431 (334.870±163.663)
HB	745 (120.728±27.941)	478 (119.839±22.941)	267 (122.318±35.154)
HCT	745 (36.771±7.886)	478 (36.424±6.345)	267 (37.394±10.058)
MCV	1,378 (82.990±8.884)	845 (81.277±8.063)	533 (85.708±9.439)
MCHC	1,378 (333.340±18.799)	845 (335.298±18.706)	533 (330.236±18.544)
MCH	1,378 (27.690±3.381)	845 (27.256±3.054)	533 (28.377±3.743)

PT, prothrombin time; APTT, activated partial thromboplastin time; INR, international standardized ratio; FBG, fibrinogen; WBC, white blood cell count; PLT, platelet count; HB, hemoglobin; HCT, hematocrit; MCV, mean corpuscular volume; MCHC, mean corpuscular hemoglobin concentration; MCH, mean corpuscular hemoglobin.

Table S2 Parameters of conventional coagulation tests and their reference range

Parameter	Normal	Hypocoagulation	Hypercoagulation/hyperfibrinolysis
PT (s)/INR	9.4–12.5	>12.5	<9.4
INR	0.8–1.2	>1.2	<0.8
APTT (s)	25.1–38.4	>38.4	<25.1
Fib (g/L)	2–4	<2	>4
D-dimer (mg/L)	0–0.24	–	>0.24
ATIII (%)	83–128	>128	<83

PT, prothrombin time; INR, international standardized ratio; APTT, activated partial thromboplastin time; ATIII, anticoagulant enzyme III.