Learning Curve for Retroperitoneoscopic Renal Pedicle Lymphatic Disconnection for Intractable Chyluria

A Single Surgeon's Experience

Long Wang,[1] Zhenyu Ou,[1] Hequn Chen,[1] Zhenzhen Cao,[2] Zhengyan Tang,[1] Xiang Chen,[1] Xiongbing Zu,[1] Longfei Liu,[1] Lin Qi[1]
Long Wang and Zhenyu Ou contributed equally to this work.

[1] Department of Urology, Xiangya Hospital, Central South University, Changsha, China
[2] Department of Gynecologic Oncology, Hunan Provincial Tumor Hospital, Changsha, China

Corresponding Author:

Lin Qi, MD; PhD
Department of Urology, Xiangya Hospital, Central South University, No.87 Xiangya Road, Changsha, Hunan 410008, China

Tel: +86 138 7315 1645
Fax: +86 731 8432 7242

E-mail: xyurology@gmail.com

Received September 2011
Accepted April 2012

Purpose: To evaluate the surgical experience and outcomes of retroperitoneoscopic renal pedicle lymphatic disconnection (RRPLD) and to define a learning curve for this minimally invasive technique to treat patients with intractable chyluria.

Materials and Methods: We collected the clinical records of 40 consecutive patients who were selected for RRPLD of 42 renoureteral units between 2007 and 2010 for chyluria by a single surgeon with no experience for this procedure. Patients' demographics and peri-operative parameters were recorded and compared. Operation time, blood loss, and other peri-operative parameters were analyzed to document the learning curve for the procedure.

Results: All the 40 patients, 14 women and 26 men, underwent RRPLD successfully, and no open conversions were needed. The median operation time was 77.5 minutes [interquartile ranges (IQR): 69.0 to 89.0] and the median blood loss was 46.5 mL (IQR: 35.0 to 67.0). A total of five complications occurred (11.9%). We divided the patient cohort to the first 20 (group 1) and the last 20 (group 2) patients since operation time reached a plateau after about 20 cases. There were significant differences in the operation time ($P = .000$) and the blood loss ($P = .006$) between the two groups. The two phases did not differ in terms of demographic data, peri-operative complications, gastrointestinal recovery time, extubation time, or hospitalization duration.

Conclusion: Retroperitoneoscopic renal pedicle lymphatic disconnection is a well standardized and reproducible procedure. This study of the learning curve of a single surgeon suggests that competence at performing RRPLD is reached after approximately 20 cases.

Keywords: laparoscopy, kidney, filariasis, lymphatic vessels, learning curve

INTRODUCTION

Chyluria is the passage of chyle into the urine through abnormal communication between the urinary tract and the lymphatic system. The most common cause of chyluria is a parasitic infection, especially Wuchereria bancrofti. Other non-parasitic causes, such as neoplasia, lymphatic malformation, abdominal trauma, or tuberculosis, are occasionally seen.[1]Although chyluria caused by filariasis is rare in Western countries, it is frequently seen in Asian countries.

Some patients can obtain satisfactory curative effects through conservative measures, including dietary management, antifilarial drugs, and retrograde renal pelvic instillation of various agents. However, a proportion of patients fail to improve with such therapy and require surgical intervention.[2] Since 1995 when laparoscopic lymphatic disconnection was adopted by Chiu and colleagues,[3] the laparoscopic technique, with minimal invasion, less complications, and rapid postoperative recovery, has been utilized more and more as the alternative surgical technique for chyluria.

Previous studies have shown that most advanced laparoscopic procedures are associated with a distinct learning curve, and the learning curve for each procedure can be defined.[4-6] It is not uncommon for an Asian urologist to operate intractable chyluria. To the best of our knowledge, the learning curve for retroperitoneoscopic renal pedicle lymphatic disconnection (RRPLD) has not been reported previously. Hence, in this study, we evaluated the impact of the learning curve on peri-operative outcomes in 40 consecutive patients who underwent RRPLD of 42 renoureteral units for intractable chyluria. Furthermore, we defined the number of cases needed to achieve reasonable results using a laparoscopic approach to perform renal pedicle lymphatic disconnection.

MATERIALS AND METHODS

Between June 2007 and August 2010, 40 consecutive patients with intractable chyluria underwent RRPLD performed by a single surgeon with no experience for this procedure and supervised by a consultant at Xiangya Hospital. The surgeon has been trained primarily in open surgery, and has had some advanced laparoscopic training during fellowship training.

All the patients were living in filariasis-prevalent regions and had typical manifestations, including milky urine, weight loss, fatigue, and anemia. The mean disease duration was 36 months (average, 2 months to 15 years). The urine chyle test was positive for all the patients. Cystoscopy after a fatty meal revealed chyluria from the left ureter in 24, the right ureter in 14, and from both sides in two cases.

Age, gender, involvement site (left or right), body mass index (BMI), operation time, blood loss, peri-operative complications, gastrointestinal recovery time, extubation time, and hospitalization duration were recorded. The operation time was defined as the time between the first skin incision and the last port closure.

Surgical Procedure

All the patients received general anesthesia, and routine lateral decubitus position were adopted. At the posterior axillary line, a 2-cm incision was made beneath the 12th costal margin. After dissecting the flank muscular layer and lumbodorsal fascia by hemostatic forcep, the index finger was inserted to the initial retroperitoneal space to sweep the peritoneum ventrally and separate the space. The creation of a working space in the retroperitoneum was performed with a homemade balloon dilator with 800 to 1000 mL air infused for 5 minutes. One 10-mm trocar for 30° laparoscope was introduced 2 cm above the iliac crest. Another 5-mm and 10-mm working trocars were inserted at the anterior axillary line under the 12th rib and the initial lumbotomy incision, respectively. A CO_2 insufflation was performed at a pressure of 12 mmHg. The extraperitoneal fat was dissected from the Gerota's fascia, which was then incised longitudinally close to the psoas magnum muscle. After removing the adipose capsule carefully, the surrounding fat tissues on the upper pole, lower pole, and the surface of the kidney were dissected. The pelvis and upper ureter became completely bare after adequately stripping the circumambient fatty and connective tissues containing lymphatic vessels (Figure 1A). Lymphatic vessels around renal arteries were disconnected using ultrasonic scissors or ligated by titanium clips, followed by incision and ligation of the vagina

vasorum on the surface of the renal arteries (Figure 1B). The same technique was used to separate and ligate the dilated lymphatic vessels around the renal vein and between the renal artery and vein (Figure 1C). During the surgical process, particular attention was paid to protect the perirenal vessels like adrenal vein, gonadal vessels, and aberrant arteries. To prevent tension on the renal vessels and nephroptosis, it was necessary to perform nephropexy. A drainage tube was introduced through the trocar above the iliac crest into the retroperitoneum.

Learning Curve for Surgery

Parameters to assess the learning curve for RRPLD were operation time, blood loss, and other peri-operative parameters. To study the learning curve, we performed a post hoc analysis, in which we subdivided the patients into two groups: the fist 20 and the last 20. We selected this cutoff because surgical times reached a plateau around the 20th patient.

Statistical Analysis

Data are presented as means with standard deviations or medians with interquartile ranges (IQR). Differences between groups and variables of patients were tested with independent samples *t* test, Mann-Whitney *U* test, or Pearson's Chi-Square test, where appropriate. Statistical analyses were performed with the SPSS software (the Statistical Package for the Social Sciences, Version 15.0, SPSS Inc, Chicago, Illinois, USA). Significance was assumed at a *P* value less than .05.

RESULTS

In all the patients, the procedures were successfully performed laparoscopically by a beginner surgeon (conversion rate, 0%). Two patients in group 2 with bilateral chyluria efflux underwent simultaneous RRPLD. As shown in Table 1, pre-operative clinical characteristics were similar between the two groups. There were no significant differences among groups with respect to age, BMI, gender, or number of illness in the left or right sides.

The median operation time was 77.5 minutes (IQR: 69.0 to 89.0; Table 2). Surgeon's experience was inversely cor-

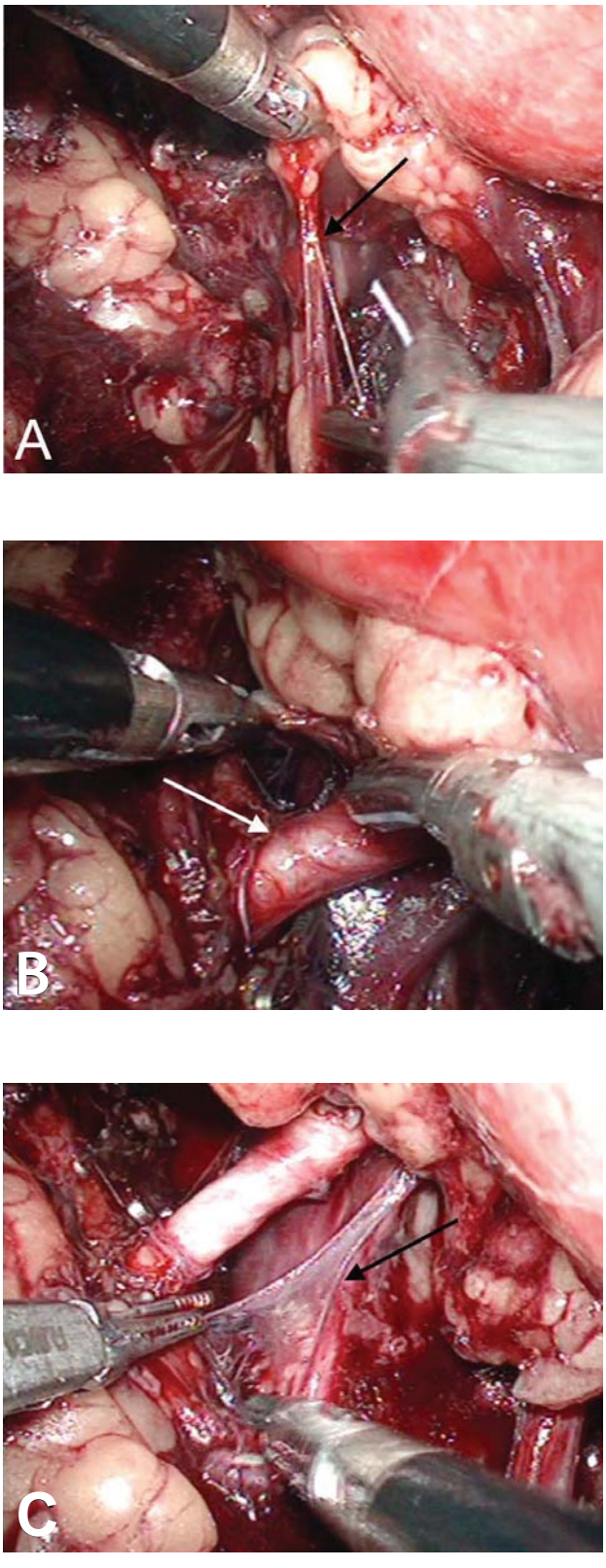

Figure 1. (A) Disconnection of lymphatic vessels around the ureter (arrow); (B) Disconnection of lymphatic vessels around the renal artery (arrow); (C) Disconnection of lymphatic vessels around the renal vein (arrow).

Table 1. Clinical characteristics of the analyzed patients.

Variables	Group 1 (cases 1 to 20)	Group 2 (cases 21 to 40)	*P*
Age, y	50.3 ± 12.7	47.4 ± 9.7	.416
Body mass index, kg/m^2	17.8 ± 2.1	18.5 ± 1.6	.242
Women/men	7/13	7/13	.000
Left/right side	13/7	13/9*	.694

*2 patients with bilateral chyluria

related with operation time, which reached a plateau around the 20th subject (Figure 2). The median operation duration significantly differed between the first 20 patients and the last 20 (90.5 versus 69.0 minutes, P = .000). The median blood loss was 46.5 mL (IQR: 35.0 to 67.0) and there was a significant difference between the two groups (55.0 versus 37.0 mL, P = .006).

Five intra- and postoperative complications were noted: an auxiliary artery branch in the lower pole of the kidney that was clipped inadvertently without any consequence (group 1), 2 inadvertent minor rupture of the inferior vena cava, which were successfully repaired using laparoscope (group 2), and 2 postoperative lymphatic leakage managed through extending the drainage time to 3.8 and 5.0 days (group 1).

Gastrointestinal recovery, extubation, and hospitalization times were also comparable between the two groups, and no significant difference was observed (Table 2).

Chyluria disappeared in all the patients immediately after the operations. The urine chyle test became negative in all the patients. During a mean follow-up period of 21 months, no gross chyluria reappeared in all the patients.

DISCUSSION

Chyluria is a rare condition in Western countries, but it is frequently reported from Asian countries, like India, China, and Japan. About 120 million individuals are affected

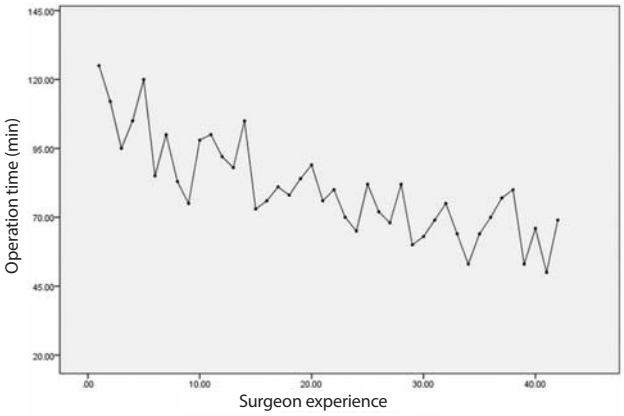

Figure 2. Operation time according to surgeon's experience.

by lymphatic filariasis worldwide.[1] Intractable chyluria not responding to conservative measures requires surgical treatment. Punekar and colleagues reported a success rate of 98% with open surgical lymphorenal disconnection.[7] With the advent and the subsequent popularity of laparoscopy, this operation can be performed laparoscopically. Chiu and colleagues reported the first transperitoneal laparoscopic lymphatic ligation for chyluria with satisfactory results after a two-year follow-up.[3] Gomella and coworkers then described retroperitoneoscopic lymphatic management of chyluria with no recurrence for over 2 years.[8]

Several clinical trials demonstrated that RRPLD has many advantages over open surgery, including minimal invasion, less blood loss, shorter postoperative hospital stay, and rapid recovery.[9-11] Furthermore, RRPLD is now accepted as the standard of care for intractable chyluria in many institutions. The present study demonstrated that RRPLD is a reproducible, safe technique requiring a short learning curve to achieve satisfying results in terms of operation duration and blood loss without jeopardizing patient's outcomes.

In surgery, the learning curve is typically defined as the number of cases required for a surgeon to perform a par-

Table 2. Correlation of surgeon's experience with clinical outcomes.

Groups	Operation time, min	Blood loss, mL	Gastrointestinal recovery time, hr	Extubation time, hr	Hospitalization time, day	Overall Complications, n (%)
Group 1	90.5 (82.0 to 102.5)	55.0 (42.5 to 72.5)	24.0 (14.3 to 39.0)	28.2 (15.3 to 36.0)	4.0 (3.1 to 5.3)	3 (15.0)
Group 2	69.0 (64.0 to 76.0)	37.0 (29.0 to 50.0)	29.5 (17.3 to 39.3)	31.5 (17.5 to 32.0)	4.5 (2.8 to 5.0)	2 (9.1)
All cases	77.5 (69.0 to 89.0)	46.5 (35.0 to 67.0)	28.0 (15.0 to 38.5)	29.0 (16.5 to 33.5)	4.3 (3.2 to 5.1)	5 (11.9)
P	.000	.006	.735	.815	.513	.656

ticular procedure to stabilize operation times and achieve acceptable outcomes.[12] We studied the first 40 patients operated by a single beginner surgeon and divided them into 2 groups according to the change tendency of operation time. Therefore, potential statistic errors arising from different laparoscopists, centers, criteria, and surgical procedures were eliminated. The learning curve is often assessed using operation duration, complication rates, and blood loss as variables. Literature data show that the mean operation duration and the blood loss range from 65 to 120 minutes and 25 to 95 mL, respectively (Table 3). When we utilize operation duration as a proxy for technical facility, we are able to delineate a learning curve of approximately 20 cases because the median operation time for the first 20 subjects was 90.5 minutes, but fell to 69.0 minutes in the last 20 patients and reached a plateau. Concerning blood loss, the results of our study were within the ranges previously reported in literature. Meanwhile, our data demonstrated a significant reduction in blood loss after the first 20 cases.

Overall complication analysis is another important parameter in estimating the safety of a surgical procedure during the learning curve. Complication rates reported in the literature are quite variable, ranging from 0% to 50% (Table 3). Hemal and associates reported 11% of lymphatic leakage in their series[13] despite the fact that a higher incidence had been reported in their previous research.[14] Seven published series reported that complications, including inferior vena cava injury, clipping of an auxiliary artery, and postoperative hematuria, occurred in a small number of patients in their series.[9-11,13-16] Similarly, the complications of the 40 subjects in our series were inferior vena cava injuries (4.8%), auxiliary artery injuries (2.4%), and lymphatic leakage (4.8%). In the present study, the overall peri-operative complications rate was 11.9%, which was within the range of other published series. Furthermore, the percentage of complications did not differ between the 2 groups. Consequently, we may assume that single surgeon experience was not statistically associated with complication rate.

In our study, there was no need for conversion to open surgery, which was reported in previous studies. The acceptable complication rate and 0% conversion rate show that the procedure can be completed safely by a surgeon with no experience of RRPLD even in the early stages of the learning curve. The present study demonstrated that gastrointestinal recovery and extubation and hospitalization times did not differ significantly as the surgeon gained more experience, suggesting that these parameters might not be suitable measures for assessing accredited laparoscopic surgeons.

Overall, we estimate that 20 cases might be an appropriate number for a beginner surgeon to complete the learning curve. These can be interpreted and explained in several ways. First, we transferred surgical skills from open surgery to RRPLD. Knowledge of surgical anatomy was advantageous in shortening the learning curve with RRPLD. Second, the experience acquired from other retroperitoneoscopic surgeries, such as radical nephrectomy and live do-

Table 3. Retroperitoneoscopic renal pedicle lymphatic disconnection: literature overview

First Author (Ref number)	Men /women	Mean age, y	Mean operation time, min	Mean blood loss, mL	Mean hospitalization, day	Major complications (n)	Complication rate, %
Hemal[14]	0/2	26.5	120	80	2.5	lymphatic leak (1)	50%
Hemal[13]	6/3	36.5	111	95	2.6	lymphatic leak (1); clipping of post segmental artery branch (1)	22.2%
Zhang[9]	3/4	49	65.0	29.3	4.7	postoperative hematuria (1)	14.3%
Jiang[15]	4/2	42	95	85	7.2	clipping of auxiliary artery branch (1)	16.7%
Zhang[10]	26/15	46.2	66.6	25	3.7	inferior vena cava injury (1)	2.4%
Lan[11]	7/2	49	77	46	6	None	0%
Xia[16]	31/47	56	92	55	6.8	inferior vena cava injury (1), clipping of an auxiliary artery (1)	2.6%
Present series	14/26	50	80.9	50.0	4.5	inferior vena cava injury (2), clipping of an auxiliary artery (1), lymphatic leak (2)	11.9%

nor nephrectomy, accommodates the laparoscopic skill that facilitates better execution of RRPLD. Third, Pre-operative discussion between team members and postoperative study of surgical videos for technical tips and pitfalls helped our team to improve step by step.

The main limitation of this study is that the learning curve described is specific to only one surgeon, with relatively small sample size of 40 patients, limiting the generalizability of the results. It is expected that any individual surgeon's learning curve varies depending on initial training and previous experience with different laparoscopic procedures. In recent years, laparoscopic surgery has become more widespread, as there is increasing information available in the literature, educational videos, and symposiums. Moreover, Rosser and coworkers reported that the younger generation, who were familiar with video games, improved their laparoscopic skills with much greater ease.[17] Hence, this number is to be taken merely as a guideline for beginner surgeons and maybe the duration for prospective mentorship by an experienced surgeon to optimize results.

CONCLUSION

Retroperitoneoscopic renal pedicle lymphatic disconnection is a well standardized and reproducible procedure with a short learning curve for a surgeon with no experience of this procedure. During the learning curve period, excellent results in terms of operation time and blood loss can be reached after about 20 cases without jeopardizing patient's outcome.

CONFLICT OF INTEREST

None declared

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