

Endourology

Laparoendoscopic Single-Site Pyeloplasty Using Additional 2 mm Instruments: A Comparison with Conventional Laparoscopic Pyeloplasty

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Purpose: Despite a recent surge in the performance of laparoendoscopic single-site surgery (LESS), concerns remain about performing LESS pyeloplasty (LESS-P) because of the technical difficulty in suturing. We report our techniques and initial experiences with LESS-P using additional needlescopic instruments and compare the results with conventional laparoscopic pyeloplasty (CL-P).

Materials and Methods: Nine patients undergoing LESS-P were matched 2:1 with regard to age and side of surgery to a previous cohort of 18 patients who underwent CL-P. In both groups, the operating procedures were performed equally except for the number of access points. In the LESS-P group, we made a single 2 cm incision at the umbilicus and used a homemade port. We also used additional 2 mm needlescopic instruments at the subcostal area to facilitate suturing and the ureteral stenting.

Results: The preoperative characteristics were comparable in both groups. Postoperatively, no significant differences were noted between the LESS-P and CL-P cases in regard to length of stay, estimated blood loss, analgesics required, and complications. But, LESS-P was associated with a shorter operative time (252.2 vs. 309.7 minutes, $p=0.044$) and less pain on postoperative day one (numeric rating scale 3.7 vs. 5.6, $p=0.024$). The success rate was 94% with CL-P (median, 23 months) and 100% with LESS-P (median, 14 months).

Conclusions: Our initial experiences suggest that LESS-P is a feasible and safe procedure. The use of additional 2 mm instruments can help to overcome the difficulties associated with LESS surgery.

Key Words: Laparoscopy; Minimally invasive; Surgical procedure; Ureteral obstruction

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INTRODUCTION

Traditionally, open dismembered pyeloplasty has been the standard treatment for ureteropelvic junction obstruction (UPJO) [1]. In 1993, Schuessler and associates described the first laparoscopic pyeloplasty [2], and since then it has been shown to result in similar outcomes to open pyeloplasty with a lower morbidity [3].

To decrease the morbidity and improve cosmetic outcomes from conventional laparoscopy, efforts have been

made to develop new techniques with multichannel single-access ports and articulating instruments that allow the laparoscopic procedure to be performed through a single skin incision that is often hidden within the umbilicus, otherwise referred to as laparoendoscopic single-site surgery (LESS). LESS has been used for diverse urological diseases and initial studies have shown that LESS is safe and feasible in comparison to conventional laparoscopic surgery [4-8]. In particular, after the report of Desai et al on the first LESS pyeloplasty (LESS-P) [9], follow-up studies

showed similar outcomes with conventional laparoscopic pyeloplasty (CL-P) [7,10].

However, LESS is still a technically challenging procedure for beginners because of the difficulty in suturing. Here, we report on our techniques and initial experience with LESS-P using additional needlescopic instruments and compare the results with CL-P.

MATERIALS AND METHODS

1. Patients

We analyzed 9 consecutive patients who underwent LESS-P between July 2009 and April 2010. The clinical data were compared with data from 18 patients out of 31 consecutive patients who underwent CL-P from November 2003 to April 2009. The 9 LESS-P patients were matched 1:2 with the 18 CL-P patients on the basis of age and side of surgery.

All patients were evaluated preoperatively with computed tomography urography and diuretic renogram. The choice of operation was based on the presence of obstruction on the diuretic renogram with either symptoms (urinary tract infection, recurrent pain, or stone formation) or functional impairment of the kidney (relative uptake $\leq 40\%$).

2. Surgical technique

All LESS-P procedures were performed by a single surgeon (D.H.H.), whereas the CL-P procedures were performed by two surgeons (17 cases by D.H.H, 1 case by S.S.J.) In both groups, the operating procedures were performed similarly, except for the number of access points. All patients underwent dismembered pyeloplasty via the transperitoneal approach. A ureteral stent was placed antegradely, except in cases where the stent had been placed before surgery.

To perform LESS-P, the patient was placed in the semi-lateral decubitus position under general anesthesia. A 2-cm midline longitudinal incision was made at the

umbilicus. We used a wound retractor (Alexis[®]; Applied Medical, Rancho Santa Margarita, CA, USA) and a surgical glove as the homemade single-port device as described in our previous series [11]. To make a single port similar to that of a commercial multichannel trocar, the inner ring of the wound retractor was inserted at the umbilicus. An outer ring was attached to a size 6½ surgical glove. We firmly fastened the first, third, and fifth glove finger tips to the end of the three trocars (two 12 mm trocars and one 5 mm trocar) with a tie or rubber band [11]. Pneumoperitoneum was made by CO₂ gas insufflation to 14 mm Hg, and a 10 mm rigid laparoscope angled at 30 degrees was inserted. The operation was performed by using conventional laparoscopic straight working instruments and 5 mm articulating instruments (Autonomy Laparo-angle[™]; Cambridge Endo, Framingham MA, USA) to overcome the lack of triangulation that occurs with a single port. We also used additional needlescopic instruments with a 2 mm trocar inserted at the subcostal area to create an environment similar to that for conventional laparoscopic pyeloplasty with ureteropelvic anastomosis (Fig. 1, 2). The 2 mm grasper was used to assist with suturing by manipulating the renal pelvis or ureter and adjusting the needle direction (Fig. 3). During dissection at the right pyeloplasty, a 2 mm trocar was also initially used for liver traction. The anastomosis was performed by means of a continuously running suture with 4-0 polygalactin suture. A ureteral stent was inserted antegradely through the 2 mm trocar by using a 5 Fr. catheter and guide-wire. The 2 mm trocar site did not need to be closed after the operation. In the CL-P group, we used two 12 mm trocars and one or two 5 mm trocars.

All patients underwent placement of a Jackson-Pratt drain through a 5 mm trocar incision in all CL-P cases and through the margin of the umbilical incision in all LESS-P cases.

The postoperative management was similar in both groups. Prophylactic antibiotics were routinely pres-



FIG. 1. 2 mm needlescopic instruments.



FIG. 2. 2 mm needlescopic instruments were inserted to create an environment similar to that of conventional laparoendoscopic surgery.

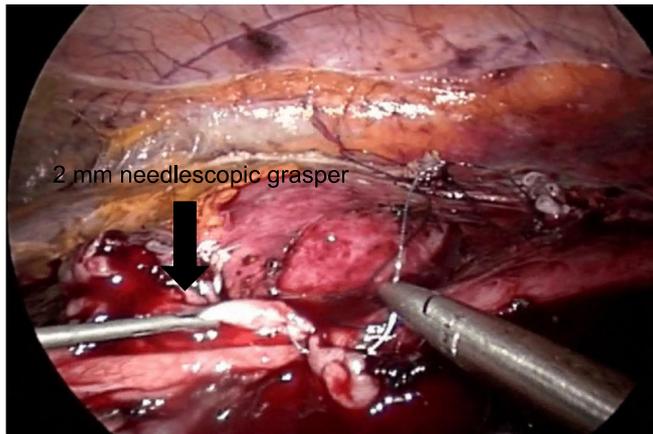


FIG. 3. 2 mm needlescopic instruments assist with suturing by manipulating tissue, adjusting in needle direction.

cribed. For pain control, we prescribed intravenous (IV) patient-controlled analgesia (PCA). Infusion of 1,500 μ g of fentanyl in 100 ml of normal saline was started at a basal infusion rate of 1.0 ml/hr with an IV infusion pump (AutoMed[®] 3200; Ace Medical, Seoul, Korea). The analgesic bolus of PCA (using a 1.0 ml bolus and a lockout time of 15 minutes in the IV PCA group) was started at the postanesthesia care unit by the patient after awakening. Additional MSO₄ was applied when the IV PCA was ineffective at reducing or eliminating the pain.

The Foley catheter was removed 2 or 3 days postoperatively. The closed suction drain was subsequently removed if the drainage output did not increase and was less than 100 ml in 24 hours after Foley catheter removal. A diuretic renogram was performed 2 and 5 months postoperatively. Thereafter, a follow-up diuretic renogram was performed every 6 months. Success was defined as both disappearance of symptoms and improvement on the diuretic renogram.

3. Statistical analysis

The perioperative parameters including operative time, intraoperative estimated blood loss, analgesic use, postoperative hospital stay, complications, and success rates were compared between the two groups. The operative time was recorded from the time of the initial skin incision to the final skin suture.

To compare postoperative pain, we used a numerical rating scale (NRS) from 0 (no pain) to 10 (worst possible pain), and we looked at the additional MSO₄ requirement on postoperative day 1 and the discharge day. The assessment of success was based on improvement in the diuretic renogram, including resolution of clinical symptoms.

Perioperative complications were classified according to the Clavien-Dindo scale [12].

All statistical analyses were performed with the SPSS ver. 17.0 (SPSS Inc., Chicago, IL, USA). Numerical data from a normal distribution were expressed as a group mean

TABLE 1. Demographic data of patients from the conventional laparoscopic pyeloplasty (CL-P) and laparoendoscopic single-site pyeloplasty (LESS-P) surgery groups

	CL-P	LESS-P	p-value
Age (median, yr)	31.5 (25-60)	39 (28-57)	0.348
Laterality [n (%)]			1.000
Right	8 (44.4)	4 (44.4)	
Left	10 (55.6)	5 (55.6)	
Gender [n (%)]			1.000
Male	11 (61.1)	6 (66.7)	
Female	7 (38.9)	3 (33.3)	
Body mass index (mean, kg/m ²)	22.9 (16.6-27.8)	23.1 (17.2-26.4)	0.858
Crossing vessel [n (%)]	3 (16.7)	2 (22.2)	1.000
Previous endoscopic management [n (%)]	0 (0)	3 (33.3)	0.029

with the standard deviation and were compared by using the Student's t-test. Numerical data from a non-normal distribution were expressed as a group median evaluated by using the Mann-Whitney rank sum test. Pearson's chi-square test was used to compare categorical data. Statistical significance was defined as $p < 0.05$.

RESULTS

The demographics of the patients in the CL-P and open LESS-P group are shown in Table 1. There were no significant differences between the 2 groups in terms of age, operation side, sex, body mass index, and crossing vessel. The number of attempts at previous endoscopic management was significantly higher in the LESS-P ($p=0.029$) group. Previous endoscopic management involved 3 retrograde endopyelotomies using a holmium laser.

The intraoperative and postoperative data for the 2 groups are presented in Table 2. All CL-P procedures were completed successfully with no conversions to open surgery and all open procedures were performed as planned. One conversion to CL-P was present in the LESS-P group because of severe adhesion resulting from previous endoscopic management and intraperitoneal operation. There was no statistically significant difference in the conversion rate to other operations, however. There was also no mortality in either the CL-P or the LESS-P group.

LESS-P was associated with a shorter operative time (252.2 vs. 309.7 minutes, $p=0.044$) and a lower NRS on postoperative day 1 (3.7 vs. 5.6, $p=0.024$).

However, there were no significant differences between the two groups in terms of length of stay, estimated blood loss volume, double J indwelling time, Foley catheter indwelling time, MSO₄ requirement, NRS on the discharge day, conversion rate to another operation, or complication rate.

Two minor adverse events developed in the LESS-P

TABLE 2. Perioperative and postoperative outcomes of the CL-P and LESS-P surgery groups

	CL-P	LESS-P	p-value
Length of hospital stay (median, day)	6 (3-8)	6 (6-9)	0.348
Operative time (mean, minute)	309.7 (180-425)	252.2 (160-350)	0.044
Estimated blood loss (median, ml)	200 (50-400)	150 (50-310)	0.232
Length of double J catheter indwelling (median, day)	46 (21-66)	45 (35-61)	0.959
Length of catheterization (median, day)	3.5 (1-6)	4 (3-6)	0.478
Additional requirement of MSO4 (median, Eq)	0 (0-100)	0 (0-100)	0.073
NRS at postoperative one day (mean)	5.6 (4-8)	3.7 (0-7)	0.024
NRS at discharge day (median)	1 (0-7)	2 (0-3)	0.318
Grade I/II complications [n (%)]	2 (11.1)	2 (22.2)	0.582
Grade IIIa/IIIb complications [n (%)]	0 (0)	0 (0)	
Conversion to other operation [n (%)]	0 (0)	1 (11.1)	0.333
Success [n(%)]	17 (94)	9 (100)	1.000

CL-P: conventional laparoscopic pyeloplasty, LESS-P: laparoendoscopic single-site pyeloplasty, NRS: numeric rating scale

group: one case of transient gross hematuria and one case of an emergency room visit for pain that was not relieved by oral medication after discharge. Both cases were relieved after conservative management.

There were also two minor adverse events in the CL-P group. One case had a transient urine leak managed with an indwelling Foley catheter. The other case had postoperative pain relieved by conservative management.

The success rate was 94% (17 of 18 cases) in the CL-P group (median 23 months) and 100% (9 of 9 cases) in the LESS-P group (median 14 months). There was no significant difference in the success rate between the two groups ($p=1.00$).

DISCUSSION

In the past 20 years, accumulating evidence has suggested that laparoscopic pyeloplasty is the standard of care in adults [3,13-15]. Several studies have shown a success rate of greater than 90% for the laparoscopic procedure, similar to that achieved with traditional open dismembered pyeloplasty [13-15]. Laparoscopic pyeloplasty is associated with a short hospital stay, decreased parenteral narcotic use, good cosmesis, and less postoperative pain [13-15]. It is still limited by problems with access ports, however. These include port site bleeding, incisional hernias, and postoperative pain caused by incisional wounds.

LESS was suggested on the basis of the assumption that reducing the number of port sites would reduce some of the problems with conventional laparoscopic surgery. Since then, LESS has been used for various urological diseases and has been shown to be feasible and safe and to have a success rate comparable to that of conventional laparoscopic surgery.

Previous reports comparing LESS with conventional laparoscopic nephrectomy have shown comparable results and potential cosmetic advantages [6,8]. Recently, Tracy et al reported the following comparative results between LESS-P and CL-P: operative time (202 vs. 257 minutes),

estimated blood loss (35 vs. 85 ml), minor and major complications (14.3% vs. 14.3%, 21.4% vs. 10%, respectively), and success rates (96% vs. 100%) [7]. These results demonstrated that LESS-P was safe and feasible and was able to achieve a similar success rate to that of CL-P with potent cosmesis. However, LESS is still a challenging procedure, especially for reconstructive surgery, because incomplete triangulation and more complex motion of the articulating instruments limits effective suturing.

For that reason, an additional 2 mm or 5 mm trocar is generally used during LESS-P. Tracy et al used a temporary 5 mm port in all cases to aid in suturing and an additional 3 mm subxyphoid port for right-sided procedures for liver traction when necessary [7]. Stein et al also used a 2 mm grasping instrument to aid in suturing [10]. In our series, we also used a 2 mm needlescopic trocar in all LESS cases. Because the needlescopic trocar is the same size as a Veress needle, for which an incision is not needed for insertion, it does not make a puncture site scar after the operation. We assumed that by using a 2 mm needlescopic trocar, the cosmetic objective of umbilical LESS, a hidden scar, could be achieved. In reality, a 2 mm needlescopic instrument has many disadvantages in use. It does not provide enough holding strength, does not have rotation function (which means that the operator must rotate his or her wrist), and requires more effort and concentration to manipulate the instrument because of the small jaw. However, despite these limitations, the instrument provided powerful support during our LESS-P. This approach supports an environment similar to that of CL-P: it provided effective traction of the bowel or liver and assisted with suturing by making triangulation. The 2 mm trocar made it easy to place a ureteral stent antegradely because it could keep the guide wire and ureter in a line. Using a 3 mm instrument instead of a 2 mm one may be a better choice for overcoming the disadvantages of the 2 mm instrument. In particular, it may be helpful for a beginner at LESS. However, the addition of a 2 mm trocar and grasper is still our routine practice for suturing in LESS pyelo-

plasty because use of the 2 mm trocar and grasper is feasible and the cosmetic effect is better.

Our study showed comparable results between LESS-P with an additional 2 mm trocar and conventional laparoscopic surgery. There were no significant differences in length of stay, estimated blood loss, MSO₄ requirement, or NRS on the discharge day. Our data also showed that the mean NRS on postoperative day 1 in the LESS-P group was lower than that in the CL-P group (3.7 vs. 5.6, $p=0.024$). We cannot precisely explain this result, but we assume that the fewer number of incisions helped to decrease the early postoperative pain. However, the pain gradually decreased throughout the hospital stay period, and when the patients were discharged, there was no significant difference. These data suggest that LESS-P may result in less pain than CL-P during the early postoperative period.

In this retrospective study, Patient-controlled analgesia (PCA) was routinely used in all patients. This use of PCA may have affected the difference in postoperative pain between the two groups. If PCA had not been used, there might have been a greater difference in pain severity between the groups.

In this study, LESS-P could be effectively performed compared with CL-P with minimal complications and a low conversion rate. The mean operation time in the LESS group was even shorter than that in the CL-P group (252.2 min vs. 309.7 minutes, $p=0.044$). However, this may be from the time difference in the operation period. Accumulated experience with intracorporeal suturing may have a decisive effect on the operation time in the LESS group. Despite the time difference, this result demonstrates that LESS-P could be performed effectively by experienced laparoscopic surgeons. LESS-P has a potential cosmetic advantage, but we were unable to assess the cosmetic advantage. Despite inserting a Jackson-Pratt drain at the umbilicus, we effectively hid the surgical scar within the



FIG. 4. A photograph of the operation scar: the single skin incision is often hidden within the umbilicus.

umbilicus during the LESS-P procedure. Furthermore, there were no wound complications in the LESS-P group. It is obvious that a hidden scar has a cosmetic advantage over an exposed CL-P scar (Fig. 4), but further studies with a validated cosmetic scale are necessary to address this issue.

There are several important limitations of our study that should be acknowledged, including the retrospective design with its inherent problems, the small number of patients, and the short-term follow-up period. Nevertheless, we consider this study to be valuable because we could show less pain in the LESS-P group during the early postoperative period in a matched control design study.

Issues such as return to everyday activities and cosmesis remain important outcomes that should be addressed by future studies to provide further insight. Also, the role of LESS pyeloplasty needs to be further confirmed by a prospective randomized study with a large number of cases and a long-term follow-up.

CONCLUSIONS

LESS-P is a technically feasible and safe procedure with the addition of 2 mm instruments to overcome associated difficulties. In our study series, the surgical outcomes of LESS-P were comparable to those of CL-P. In addition, LESS-P could decrease early postoperative pain.

However, functional outcome data with long-term follow-up are needed to establish whether LESS pyeloplasty should be the standard option for UPJO treatment.

Conflicts of Interest

The authors have nothing to disclose.

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