

Comparison of the Efficacy and Safety of Laparoendoscopic Single-Site Surgery with Conventional Laparoscopic Surgery for Upper Ureter or Renal Pelvis Stones in a Single Institution: A Randomized Controlled Study

Juhyun Park¹, Seung Bae Lee¹, Sung Yong Cho¹, Chang Wook Jeong², Hwancheol Son¹, Yong Hyun Park³, Hyeon Hoe Kim², IslahMunjih Ab Rashid⁴, Hyeon Jeong^{1*}

Purpose: To evaluate the utility and safety of laparoendoscopic single-site surgery (LESS) in comparison with conventional laparoscopic (CL) surgery for the treatment of upper urinary tract stones.

Material and Methods: Between June 2011 and May 2012, 20 patients with upper urinary tract stones were included in this prospective randomized study. The patients were assigned into the LESS group or CL group in a one-on-one manner using a random table. The clinical parameters were evaluated in the immediate postoperative period, and the stone clearance rate was evaluated via non-contrast computer tomography at one month postoperatively.

Results: There were no significant differences in patient demographics or preoperative stone sizes between the two groups. The perioperative parameters, including operative time, estimated blood loss, postoperative pain scores, length of hospital stay, and changes in renal function, were comparable. No transfusions or open conversions were required in either group. The incidence of residual stones was lower in the LESS group (1 case) than in the CL group (2 cases). However, this difference was not statistically significant.

Conclusions: For large and impacted upper ureteral stones, the effectiveness and safety of LESS were equivalent to those of CL. Further randomized control trials with larger sample sizes are needed to strengthen the conclusions of this study.

Keywords: Urinary Calculi; Ureteral calculi; Kidney calculi; Laparoscopy; Prospective studies

INTRODUCTION

Less invasive techniques, such as extracorporeal shock wave lithotripsy (ESWL), percutaneous nephrolithotomy (PCNL) and ureteroscopic lithotripsy (URS), have recently become mainstream in the treatment of urinary stones.^(1,2) However, despite the development and advances of these excellent techniques, invasive surgical procedures are still used for certain cases, such as those with large stone burdens, difficult stone positions, or coexisting obstructions. In such cases, laparoscopic surgery for urolithiasis can be a good alternative to open surgery, which is a very invasive proposition.⁽³⁻⁵⁾ In contrast, the recently introduced laparoendoscopic single-site surgery (LESS) method uses only one port for the laparoscopic instrument manipulation and can thereby prevent internal organ damage and reduce the risk of bleeding from the initial blind trocar insertion.⁽⁶⁾ LESS is known to provide better cosmetic outcomes and less postoperative pain than conventional laparoscopic (CL)

surgery.⁽⁷⁾ The feasibility of LESS for urinary stones has been proven in several studies;⁽⁸⁻¹⁰⁾ however, few prospective randomized controlled studies comparing LESS with CL for urinary stone have been undertaken. Therefore, we intended to examine the utility and safety of LESS for large upper urinary tract stones through a prospective randomized controlled trial in which the LESS procedure was compared with CL.

MATERIALS AND METHODS

Study Population

Between June 2011 and May 2012, 20 patients with upper ureteral stones were included in the study. The indications for the operations were obstructive or impacted ureteral stones larger than 15 mm in the upper part of the ureter following previous ESWL failure (**Figure 1**). Patients were randomly assigned in a one-on-one manner into the LESS or CL group via the use of a randomization table. The surgeons were informed of the type of

¹Department of Urology, Seoul Metropolitan Government Seoul National University Boramae Medical Center, Seoul, Korea.

²Department of Urology, Seoul National University Hospital, Seoul, Korea.

³Department of Urology, Seoul St. Mary's Hospital, Seoul, Korea.

⁴Urology Unit, Department of Surgery, International Islamic University Malaysia, Kuala Lumpur, Malaysia.

*Correspondence: Department of Urology, Seoul Metropolitan Government Seoul National University Boramae Medical Center, 20 Boramae-Ro 5-Gil, Dongjak-gu, Seoul, 07061, Korea.

Tel: +82 2870 2392. Fax: +82 2870 3863. E-mail: drjh@brm.co.kr.

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Table 1. Comparison of preoperative parameters between LESS and CL groups.

	LESS ^a	CL ^a	P Value
No. of patients	10	10	
Age (years)	57.7 ± 13.2	51.8 ± 17.0	.393
Gender			1.0
Male	9	9	
Female	1	1	
Diabetes mellitus	4	3	.999
Hypertension	5	4	.999
Height (cm)	167.8 ± 8.2	167.9 ± 7.4	.969
Weight (kg)	75.3 ± 12.5	73.9 ± 15.0	.821
BMI (kg/m ²)	26.6 ± 3.2	26.1 ± 4.2	.796
Preoperative Hb (g/dL)	14.2 ± 1.5	14.1 ± 1.8	.970
Preoperative sCr (mg/dL)	1.10 ± 0.35	1.04 ± 0.23	.940
Preoperative eGFR (mL/min)	73.6 ± 20.0	76.6 ± 20.2	.821
Stone location			.999
No. of renal pelvis stone	6	5	
No. of upper ureter stone	4	5	
No. of concomitant calyceal stone	8	7	.999
Max size of stone (mm)	23.5 ± 7.7	20.5 ± 5.4	.383
Stone volume (mm ³)	2804.3 ± 1883.3	2084.9 ± 1219.9	.326
Preoperative pain score (VAS)	4.9 ± 3.7	4.3 ± 2.5	.684

Abbreviations: LESS, laparoendoscopic single-site surgery; CL, conventional laparoscopy; BMI, body mass index; Hb, hemoglobin; sCr, serum creatinine; eGFR, estimated glomerular filtration rate; VAS, visual analog scale; Max, maximum
^aData is presented as mean ± SD or absolute numbers

laparoscopic procedure when the patient was admitted to the hospital. Patients with anatomical abnormalities of the urinary tract, such as a horseshoe kidney and ureteropelvic junction (UPJ) obstruction, were excluded from the study. Patients with history of previous abdominal surgery were also excluded from the study.

Ethical Standards

This study design and the use of patients' information that was stored in the hospital database were approved by the Institutional Review Board (IRB) at the Seoul Metropolitan Government-Seoul National University Boramae Medical Center. The approval number is 06-2011-46. The planned study was explained to the patients in detail, and written informed consent was obtained from each patient. Our study was conducted according to the ethical standards delineated in the 1964 Declaration of Helsinki and its later amendments.

Surgical Procedures

All patients were positioned in a modified flank position that is typical of any laparoscopic kidney surgery. All of the procedures were performed under general anesthesia, and the kidneys were approached transperitoneally in both the LESS and CL procedures. In LESS, we utilized the commercially available access port (Octoport™, DalimSurgNET Corp, Seoul, Korea) to gain access to the peritoneal cavity.⁽¹¹⁾ Pre-bent instruments were applied through these access devices to optimize

the range of motion. A 3-cm incision was made at the umbilicus for the placement of the Octoport™ (Figure 2). Meanwhile, a Veress needle was used to create the initial pneumoperitoneum prior to the insertion of the first port in CL. The camera port was placed 2 cm below the umbilicus at the lateral margin of the rectus muscle. Under direct laparoscopic guidance, two instrument ports were inserted: a 12-mm port at the anterior axillary line at the level of the umbilicus and a 5-mm port 7-8 cm cephalad to the camera port. The subsequent laparoscopic procedures were similar in both groups. The colon was reflected medially along the anatomical white line of Toldt to expose the kidney. We followed the course of the ureter as a guide in the identification of the UPJ. Subsequently, a vertical incision was made at the hydronephrotic ureter above the stone level to gain access to the main stone. If there were any calyceal stones besides the upper urinary tract stone, the flexible nephroscope was used to localize and remove them (Figure 3). A ureteral stent was laparoscopically inserted into each patient at the completion of the procedure. The ureterotomy or pyelotomy incision was interruptedly closed using 4/0 polyglycolic acid suture. Finally, a drain was placed in the perirenal space.

Clinical Parameters

The patients' clinical parameters, including body mass

Table 2. Comparison of perioperative parameters between LESS and CL groups.

	LESS ^a	CL ^a	P Value
Operative time (min)	167.4 ± 80.2	190.3 ± 135.8	.850
Time using flexible nephroscopes (min)	15.0 ± 18.4	19.0 ± 22.3	.745
Estimated blood loss (mL)	51.0 ± 96.6	64.0 ± 102.7	.606
Postoperative hospital stay (day)	3.9 ± 1.7	3.5 ± 1.6	.672
Postoperative Hb (g/dL)	13.9 ± 1.4	13.7 ± 1.5	.970
Postoperative serum Cr (mg/dL)	1.07 ± 0.31	0.98 ± 0.18	.733
- Change in serum Cr	-0.07 ± 0.17	-0.08 ± 0.16	.912
Postoperative eGFR (mL/min)	79.3 ± 19.3	81.6 ± 21.9	.940
- Change in eGFR	4.7 ± 14.3	5.6 ± 11.2	.739
Pain scores on operative day (VAS)	6.9 ± 2.0	6.4 ± 2.5	.631
Pain scores at discharge (VAS)	2.4 ± 0.5	2.3 ± 0.8	.684
Postoperative complication			.255
No complication	6	8	
Hematuria	1	0	
Fever	3	1	
Ureteral stent reposition or reinsertion	1	1	
No. of patient with residual stone	1	2	.999
Stone free rate (%)	90%	80%	.999

Abbreviations: LESS, laparoendoscopic single-site surgery; CL, conventional laparoscopy; Hb, hemoglobin; sCr, serum creatinine; eGFR, estimated glomerular filtration rate; VAS, visual analog scale
^aData is presented as mean ± SD or absolute numbers

index (BMI), serum creatinine (sCr), estimated glomerular filtration rate (eGFR), hemoglobin, maximal stone size and volume, and pain scores, were determined preoperatively. The operative time, flexible nephroscope use time, estimated blood loss, pain scores, and intraoperative complications were recorded on the operative day. The operative time was measured from skin incision to skin closure including the flexible nephroscope use time. The duration of the hospital stay and the pain scores were noted and recorded at the discharge of the patient from the hospital. The postoperative hemoglobin, sCr and eGFR were checked two weeks after surgery when the ureteral stents were removed. Non-contrast computed tomography (NCCT) was performed at one month postoperatively. Stone-free status was judged at that time, and was defined by the absence of residual stone or the presences of residual stones ≤ 2 mm.

Statistical Analysis

The continuous data are presented as the mean ± the SD. The Mann-Whitney U test and the Fisher's exact test were used to investigate several parameters and identify significant differences between the two groups. Two-sided $P < .05$ was considered statistically significant. The data were analyzed using commercially available software (SPSS version 20.0, IBM SPSS Statistics, Chicago, IL, USA).

RESULTS

A total of 20 patients were included in this study and divided equally into two groups. There were no signif-

icant differences between the LESS and CL groups in any of the preoperative parameters (**Table 1**).

The intraoperative parameters were also comparable between the LESS and CL groups (**Table 2**). Neither transfusion nor open conversion was required in any case in either group.

There were no additional procedures for the residual stones because the patients were asymptomatic, and the sizes of all residual stones were smaller than 2 mm, i.e., they were limited to clinically insignificant residual fragments.

DISCUSSION

In this era of less invasive surgical techniques, URS and PCNL were the first treatment options for large upper tract stones.^(12,13) However, for upper tract stones larger than 2 cm, the efficacy of URS decreases, whereas its complication risk increases.⁽¹⁴⁾ PCNL also has a risk of complications, such as renal parenchymal injury, bleeding, and even urosepsis, during the PCNL tract formation.⁽¹⁵⁾ Therefore, we were forced to choose from invasive surgical procedures for the upper tract stones in our study. In these situations, we found that laparoscopic surgery can be a good alternative to very invasive treatments for urolithiasis.⁽³⁻⁵⁾ With the rapidly increasing frequency of the application of laparoscopy in the field of urology, the acceptance of laparoscopic stone surgery as an alternative to open stone surgery is growing. Whereas the 2007 European Urological Association Guidelines on urolithiasis considered laparoscopic stone surgery to be



Figure 1. Simple X-ray image of impacted UPJ stone with multiple calyceal stones. This patient was assigned into LESS group.

‘option’⁽¹⁶⁾, this procedure was ‘highly recommended’ in the 2009 version, and upgraded to ‘preferred’ relative to open stone surgery in the 2016 version, given that the surgeon has sufficient experience.⁽¹⁷⁾ Indeed, laparoscopic surgery is known to be superior to PCNL in terms of the risks of complications such as bleeding.^(3,5,18) Laparoscopic surgery has the advantage of being harmless to the renal parenchyma and a presumed lower risk of intraoperative bleeding.^(3,18) Tefekli et al. reported the results of a matched comparative analysis between laparoscopic pyelolithotomy and PCNL for renal stone surgery. These authors found that the operative time and hospital stay were shorter in PCNL group, but the postoperative hemoglobin decrease and transfusion rate were lower in the laparoscopic surgery group.⁽¹⁹⁾ Al-Hunayan et al. also reported similar results base on their randomized



Figure 2. Octoport™, access port for LESS ureterolithotomy was placed at the umbilicus. It has a camera port of 5/10 mm, a 5/12 mm port and two 5 mm ports.

controlled study. In that study, even the stone-free rate was superior in the laparoscopic surgery group.⁽²⁰⁾ LESS has attracted attention as the latest laparoscopic technique. LESS generally uses only one port for laparoscopic instrument manipulation and thus can minimize port site-related problems and prevent the risk of initial blind trocar insertion, which is an essential procedure during CL. LESS is also better than CL in terms of cosmetic outcomes and postoperative pain control.^(5, 7, 10) Cosmetic appearance should be an area of interest in LESS pyelolithotomy because urinary stones do affect young female patients for whom aesthetic outcome is a particular concern.^(21,22) White et al. reported superior cosmetic outcomes in a LESS group in his study of LESS abdominal sacrocolpopexy.⁽²¹⁾ Raybourn and his colleagues also reported better cosmetic outcomes in patients who underwent LESS simple nephrectomy.⁽²²⁾ Furthermore, LESS for urinary stones does not require a large incision for the removal of the specimen, which may further improve the cosmetic outcome (**Figure 4**). However, our study did not demonstrate any significant differences in postoperative pain or the length of hospital stay between the LESS and CL groups. We assume the surgery type resulted in these unexpected findings. For example, whereas laparoscopic nephrectomy requires an additional skin incision for tissue retrieval, pyelolithotomy does not require an additional skin incision for stone retrieval, even in cases of CL pyelolithotomy.^(3,4) This difference is a possible reason for the lack of significant differences between the two groups in terms of postoperative pain and hospitalization. LESS is performed through a single port through which the telescope and the dissecting surgical instruments enter the abdominal cavity through the same incision. This procedure can lead to the loss of triangulation and distance, a clash of the surgical instruments, difficulty in the overall performance of the surgery, and consequently a presumably longer operative time.⁽⁷⁾ However, in our series, we observed that the operative time was shorter in the LESS group than in the CL group, although this difference did not reach statistical significance. Raman et al. compared LESS and CL for nephrectomy procedures and found no difference in the operative times.⁽²³⁾ Stein et al. also reported no statistically significant difference in the operative times for LESS and CL pyeloplasty.⁽²⁴⁾ We assume that the advent of new endoscopic tech-



Figure 3. Removed UPJ stone and calyceal stone



Figure 4. The postoperative wound of LESS ureterolithotomy. The patient is left with only a small invisible scar at the umbilicus.

nologies and instruments has eased the performance and shortened the duration of LESS surgery. Furthermore, we also believe that once the learning curve has reached a plateau and the surgeon has become sufficiently experienced with the LESS technique, there should be no difference in the operative times of LESS and CL. In our study, we demonstrated that LESS, at least as performed by an expert, is as efficacious as CL surgery in the removal of upper ureter stones. Our study provides good evidence supporting the use of LESS for urolithiasis. Because the present study was prospective, we admit the inherent weakness of our study due to the small number of patients. Patients with large stone burdens, stones greater than 15 mm and those with multiple accompanying calyceal stones are not common. The continuous evolution and development of telescopes and dissecting instruments for LESS promises the continued evolution of this technique.

CONCLUSION

Our results demonstrated that when performed by skillful surgeons, the effectiveness and safety of LESS are equivalent to those of CL in the surgical treatment of upper urinary tract stones. Further randomized control trials with larger sample sizes are needed to strengthen the conclusions of this study.

CONFLICT OF INTEREST

Nothing to declare

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