Review Article

Laparoendoscopic single site surgery versus conventional laparoscopy for transperitoneal pyeloplasty: A systematic review and meta-analysis

Luis Felipe Brandao, Humberto Laydner[1], Homayoun Zargar[2], Fabio Torricelli[3], Cassio Andreoni, Jihad Kaouk[2], Riccardo Autorino[1]

Division of Urology, Federal University of Sao Paulo, [3]Division of Urology, Medical School, University of Sao Paulo, Sao Paulo, Brazil, [1]Urology Institute, University Hospitals Case Medical Center, [2]Glickman Urological and Kidney Institute, Cleveland Clinic, Cleveland, OH, USA

Abstract

We aimed to review studies comparing the outcomes of the laparoendoscopic single site (LESS) pyeloplasty with those of conventional laparoscopic pyeloplasty (CLP). A systematic review of the literature was performed according to the PRISMA (preferred reporting items for systematic reviews and meta-analysis) criteria. The methodological quality of the studies was rated according validated scales. The level of evidence (LE) was reported as described by the Oxford criteria. Preoperative demographic parameters and perioperative outcomes between the two surgical techniques were assessed. A meta-analysis of the included studies was performed. A total of 5 studies were elected for the analysis, including 164 cases, 70 (42.6%) of them being LESS and 94 (57.4%) being CLP. Four studies were observational retrospective comparative studies (LE: 3a-4); one was a prospective randomized controlled trial (LE: 2b). There was no significant difference in age, body mass index, gender, side and presence of the crossing vessel, between the groups. There was no significant difference regarding the operative time (weight mean difference [WMD]: −7.02; 95% confidence interval [CI]: −71.82–57.79; $P = 0.83$) and length of hospital stay (WMD: 0.04; 95% CI: −0.11–0.20; $P = 0.58$), whereas the estimated blood loss was statistically lower for LESS (WMD: −16.83; 95% CI: −31.79–−1.87; $P = 0.03$). The postoperative use of analgesic favored the LESS group but without reaching statistical significance (WMD: −7.52; 95% CI: −17.56–2.53; $P = 0.14$). In conclusion, LESS pyeloplasty offers comparable surgical and functional outcomes to CLP while providing the potential advantages of less blood loss and lower analgesic requirement. Thus, despite being more technically challenging, LESS pyeloplasty can be regarded as a minimally invasive approach for patients seeking fewer incisional scars.

Key Words: Comparison, laparoendoscopic single site surgery, laparoscopy, meta-analysis, pyeloplasty

Address for correspondence:
Dr. Riccardo Autorino, Urology Institute, University Hospitals Case Medical Center, Cleveland, OH, USA. E-mail: ricautor@gmail.com
Received: 28.11.2014, **Accepted:** 26.03.2015

Access this article online	
Quick Response Code:	Website: www.urologyannals.com
	DOI: 10.4103/0974-7796.156145

INTRODUCTION

Minimally invasive treatment options for ureteropelvic junction obstruction (UPJO) have been widely implemented over the last 20 years.[1] In 1993, the first cases of laparoscopic pyeloplasty in the adult population were reported by Schuessler *et al.*[2] and Kavoussi and Peters.[3] Gettman *et al.* reported the first robot-assisted laparoscopic pyeloplasty series in 2002.[4]

The concept of laparoendoscopic single site surgery (LESS) has been recently introduced in urology, and a variety of extirpative and reconstructive procedures has been shown to be feasible,[5] although the advantages of the technique over standard laparoscopy remain to be determined.[6]

Due to the reconstructive nature with no need for the extraction site incision it is believed that patients undergoing pyeloplasty might be ideal candidates for LESS.

Laparoendoscopic single site and robot-assisted LESS pyeloplasty were first reported in 2008.[7,8] Since then, several groups worldwide have implemented the procedure using a variety of techniques.[9-12] Tracy *et al.* first compared the outcomes of LESS pyeloplasty with those of conventional laparoscopic pyeloplasty (CLP).[13]

The aim of this study is to systematically review available studies comparing the outcomes of the LESS pyeloplasty with those of CLP and to test the hypothesis of any advantage of LESS over laparoscopy.

MATERIALS AND METHODS

Literature search and studies selection

A systematic review of the literature was performed on January 28, 2015 using the PubMed, Scopus, and Embase databases. Identification and selection of the studies were conducted according to preferred reporting items for systematic reviews and meta-analysis criteria (www.prisma-statement.org) [Figure 1] using the following search terms: LESS pyeloplasty, Laparoendoscopic single-site, pyeloplasty. Only studies comparing LESS pyeloplasty to multiport laparoscopy were considered eligible to be included in the analysis. All titles were screened for manuscripts written in the English language, and excluding studies on pediatric patients. Data were extracted independently by two authors. Conflicts were resolved by recommendations from senior authors.

Study quality assessment

The methodological quality of the studies was rated according the Newcastle-Ottawa Scale (NOS) for observational retrospective studies[14] and the Jadad scale for randomized controlled trials (RCTs).[15] The level of evidence (LE) was reported as described by the Oxford Center for Evidence-based medicine.[16]

Data extraction and outcomes of interest

Preoperative demographic parameters (age, gender, body mass index [BMI], side) and perioperative outcomes (estimated blood loss, operative time, hospital length of stay, complications, conversions, use of morphine equivalent and rate of procedure failure) between the two surgical techniques were assessed. Conversion was defined as a procedure not completed using the same technique as initially planned. Success rate was determined for each study according to the clinical and/or radiological criteria used by the authors of each study. Postoperative complications within 30 days after surgery were graded according to the Clavien-Dindo grading system.[17]

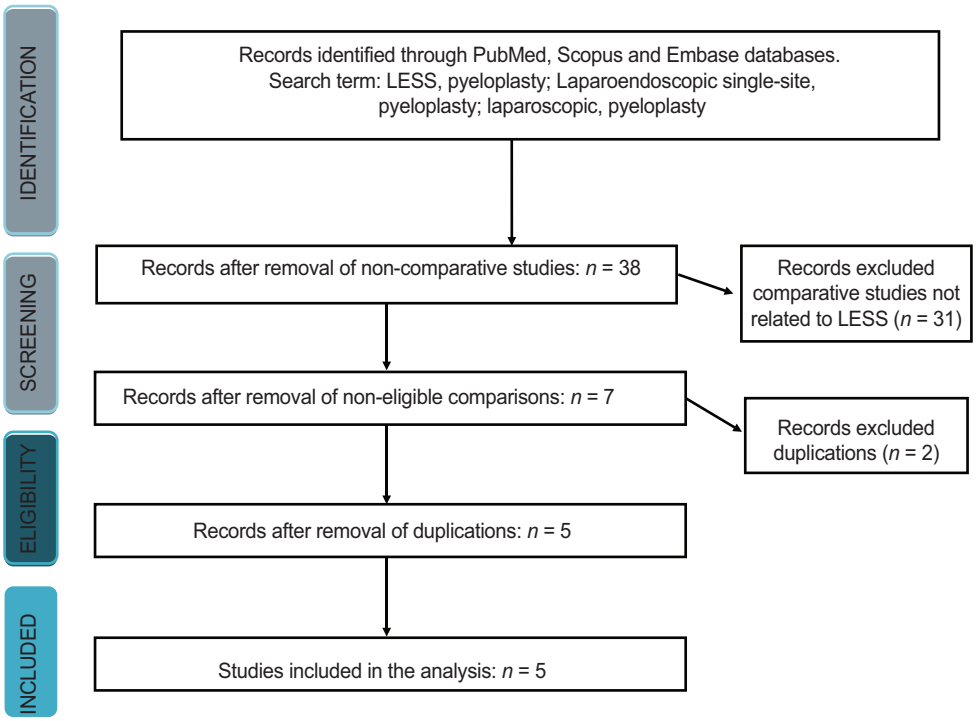

Figure 1: PRISMA diagram

Statistical analysis

A meta-analysis of the current studies was performed. Odds ratio (OR) or risk ratio was used for all binary variables, and weight mean difference (WMD) or standardized mean difference was used for the continuous parameters.

For the studies presenting continuous data as means and range, estimated standard deviations were calculated using the methodology described by Hozo *et al.*[18] Pooled estimates were calculated with the fixed-effect model (Mantel-Haenszel method),[19] if no significant heterogeneity was identified; alternatively, the random-effect model (DerSimonian-Laird method) was used when significant heterogeneity was detected.[20]

The final pooled effects were reported by the *Z*-test and $P < 0.05$ was considered as statistically significant. In order to assess the heterogeneity among the included studies, the Cochrane Chi-square test and inconsistency (I^2) were used. The data analysis was performed using the Review Manager software (Revman version 5.2.8, Cochrane Collaboration, Oxford, UK).

RESULTS

Description of included studies and quality assessment

A total of 5 studies were elected for the analysis, including 164 cases, 70 (42.6%) of them being LESS and 94 (57.4%) being CLP. Four studies were observational retrospective case-control studies. Two of them compared consecutive series (LE]: 3b);[13,21] one performed a retrospective nonconsecutive study (LE: 4);[22] one compared a matched cohort (LE: 3a)[23] one of them was a prospective RCT (LE: 2b).[24] The methodological quality of the retrospective studies was relatively high, with all the studies reporting at least 7 out of 9 stars, but with a low LE between 3 and 4. Nevertheless, the only RCT study was graded as low quality, reporting 2 out of 5 points [Table 1].

Patients' demographics and perioperative outcomes

A transperitoneal approach was used in all cases. There was no significant difference in age, BMI, gender, side and presence of the crossing vessel, between the groups [Table 2].

Tracy *et al.*[13] presented a higher rate of previous endoscopic management for the laparoscopic group (7.1% vs. 21.4%; $P = 0.39$),[10] while Ju *et al.*[21] demonstrated a significantly higher previous endoscopic management for the LESS group (33.3% vs. 0%; $P = 0.02$). Furthermore, Stein *et al.* reported a not statistically significant higher incidence of prior abdominal surgery for the laparoscopic group (31% vs. 19%; $P = 0.6$).[22]

Table 1: Characteristics and quality assessment of the included studies

Study	Level of evidence	Study design	Quality assessment tool	Quality score
Tugcu *et al.*	2b	RCT	Jadad scale*	2 of 5 points
Tracy *et al.*	3b	CS	NOS	7 of 9 stars
Stein *et al.*	4	NCR		8 of 9 stars
Naitoh *et al.*	3a	NCR*		7 of 9 stars
Ju *et al.*	3b	CS		8 of 9 stars

*Jadad scale for RCT studies (range of score quality: 0-2=Low; 3-5=High), *Matched case-control study. RCT: Randomized controlled trial, CS: Consecutive observational study, NCR: Nonconsecutive retrospective study, NOS: Newcastle-Ottawa Scale for observational studies

Table 2: Demographics

	LESS pyeloplasty	Laparoscopic pyeloplasty	*P*
Number of cases, *n* (%)	70 (42.6)	94 (57.4)	
Age, years; (mean±SD)	36.4±3.32	37.3±5.66	0.95
BMI^, kg/m^2; (mean±SD)	23.8±0.98	25.9±3.1	0.19
Male gender*, *n* (%)	24 (34.2)	35 (37.2)	0.93
Left side, *n* (%)	37 (52.8)	49 (52.1)	0.96
Crossing vessel^ψ, *n* (%)	19 (27.1)	24 (25.5)	0.31

*Data not available in the study by Stein *et al.*, ^Data not available in the study by Naitoh *et al.*, ψData not available in the study by Tugcu *et al.* LESS: Laparoendoscopic single site, BMI: Body mass index, SD: Standard deviation

The main surgical outcomes are presented in Table 3. There was no significant difference regarding the operative time (WMD: −6.59; 95% confidence interval [CI]: −62.72–49.53; $P = 0.82$) [Figure 2], and length of hospital stay (WMD: 0.04; 95% CI: −0.11–0.20; $P = 0.58$) [Figure 3]. The estimated blood loss was significantly lower for LESS (WMD: −16.83; 95% CI: −31.79–−1.87; $P = 0.03$) [Figure 4]. Only one conversion was reported by Ju *et al.* and this occurred in the LESS group.[21]

Complications are summarized in Table 4. The postoperative complication rate was higher, but not significantly, in the LESS group (OR: 2.11; 95% CI: 0.65–6.89; $P = 0.22$) [Figure 5]. There was no significant difference in minor (5.7% vs. 6.3%; $P = 0.63$) as well as major (grade > 3) complications (4.2% vs. 2.1%; $P = 0.20$), when comparing LESS and conventional laparoscopy, respectively.

The postoperative use of analgesic (morphine equivalents) favored the LESS group but without reaching statistical significance (WMD: −7.52; 95% CI: −17.56–2.53; $P = 0.14$) [Figure 6]. The overall success rate was similar between groups (OR: 0.92; 95% CI: 0.23–3.74; $P = 0.91$) [Figure 7].

DISCUSSION

The potential advantages of using the LESS technique over conventional laparoscopy include decreased postoperative pain,

Table 3: Surgical outcomes

Study	Cases, *n*		OT, min		EBL, ml		LOS, days		Morphine equivalent, mg		Success rate*, *n* (%)	
	LESS	CLP	LESS	CLP	LESS	CLP	LESS	CLP	LESS	CLP	LESS	CLP
Naitoh *et al.* 2014	12	12	248±86	253±45	6.5±4.2	7.6±3.1	-	-	-	-	12 (100)	12 (100)
Tugcu *et al.* 2013	19	20	195.21±12.15	145.62±15.34	55.67±6.71	45.84±5.22	2.12±0.23	2.06±0.34	16.11±9.24	32.16±14.18	18 (94.7)	19 (95)
Ju *et al.* 2011	9	18	252.2±47.5	309.7±61.25	150±65	200±87.5	6±0.75	6±1.25	3.7±1.75	5.6±1.25	9 (100)	17 (94.4)
Stein *et al.* 2010	16	16	215±78	183±29	79±43	87±38	2.2±0.4	2.4±1.4	41.7±48	49.5±32.7	14 (87.5)	15 (93.7)
Tracy *et al.* 2009	14	28	202±15.5	257±62.5	35±6.25	85±43.75	1.28±0.41	1.23±0.74	34±29.25	38±29.75	14 (100)	27 (96.4)

*Success rate defined in a different way by the different authors (see methods section). Values reported as mean±SD for continuous variables.
LESS: Laparoendoscopic single site surgery, CLP: Conventional laparoscopic surgery, OT: Operative time, EBL: Estimated blood loss, LOS: Length of stay

Table 4: Complications

Study	Cases, *n*		Complications, *n* (%)		Clavien grade I-II, *n* (%)		Clavien grade ≥III, *n* (%)	
	LESS	CLP	LESS	CLP	LESS	CLP	LESS	CLP
Naitoh *et al.* 2014	12	12	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Tugcu *et al.* 2013	19	20	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Ju *et al.* 2011	9	18	2 (22)	2 (11.1)	2 (22.2)	2 (11.1)	0 (0)	0 (0)
Stein *et al.* 2010	16	16	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Tracy *et al.* 2009	14	28	5 (35.7)	6 (21.4)	2 (14.3)	4 (14.3)	3 (21.4)	2 (10)

LESS: Laparoendoscopic single site surgery, CLP: Conventional laparoscopic surgery

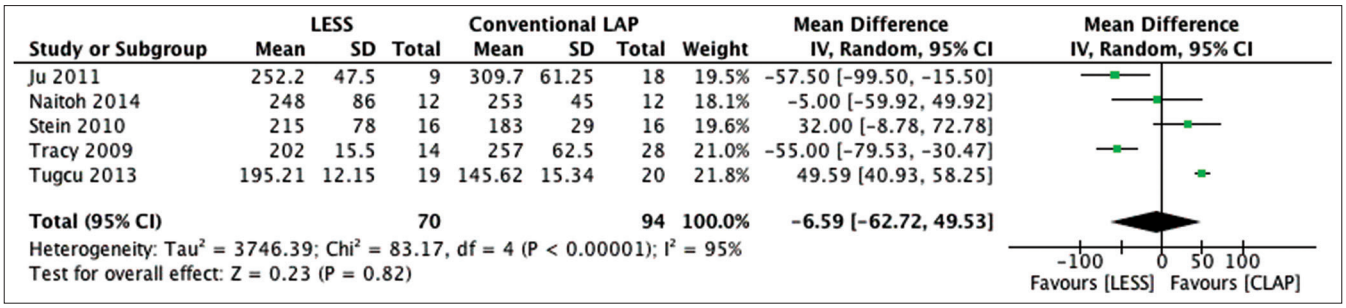

Figure 2: Laparoendoscopic single site versus CLP: Forrest plot of operative time (min)

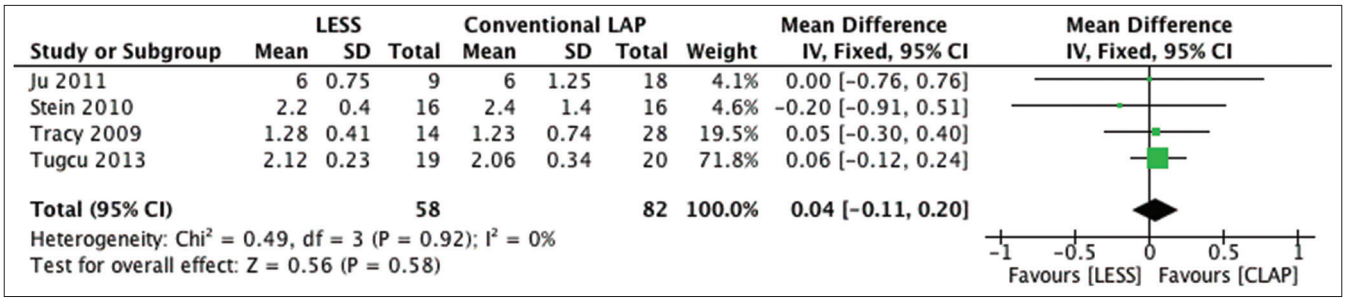

Figure 3: Laparoendoscopic single site versus CLP: Forrest plot of length of stay (days)

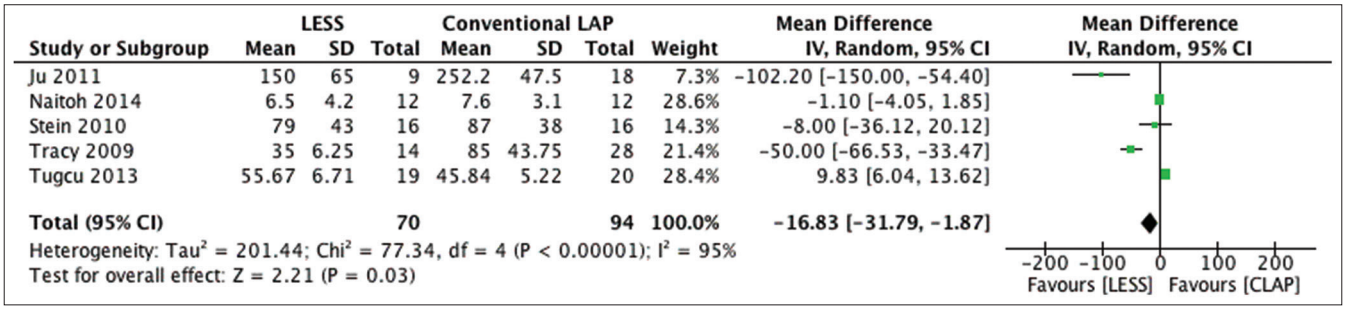

Figure 4: Laparoendoscopic single site versus CLP: Forrest plot of estimated blood loss (ml)

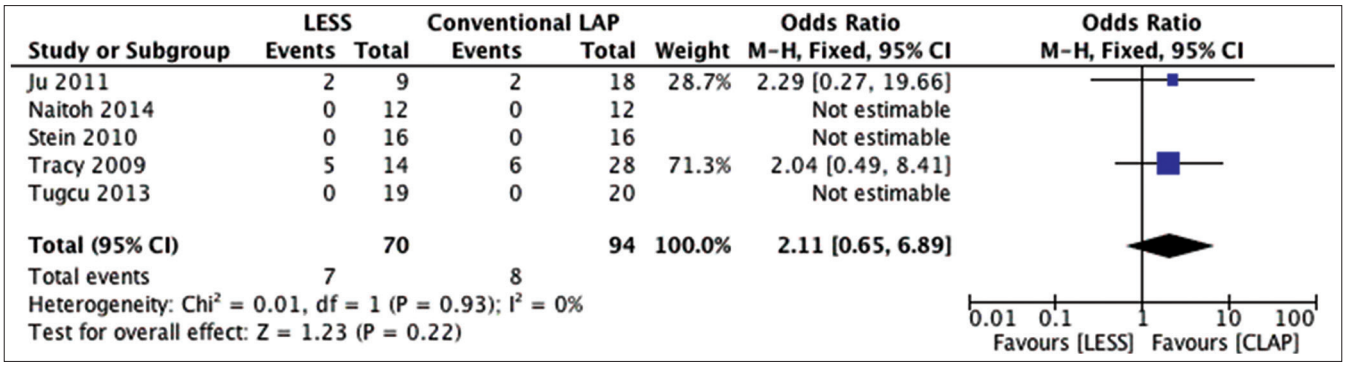

Figure 5: Laparoendoscopic single site versus CLP: Forrest plot of postoperative complication rate

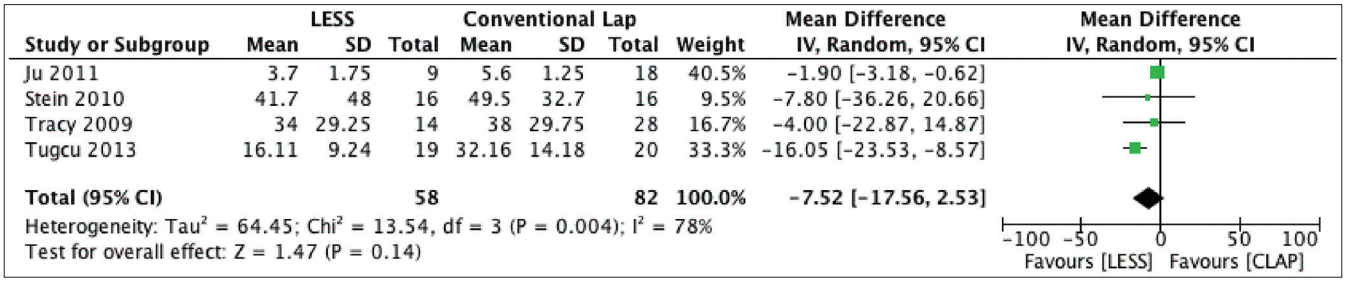

Figure 6: Laparoendoscopic single site versus CLP: Forrest plot of morphine equivalents use (mg)

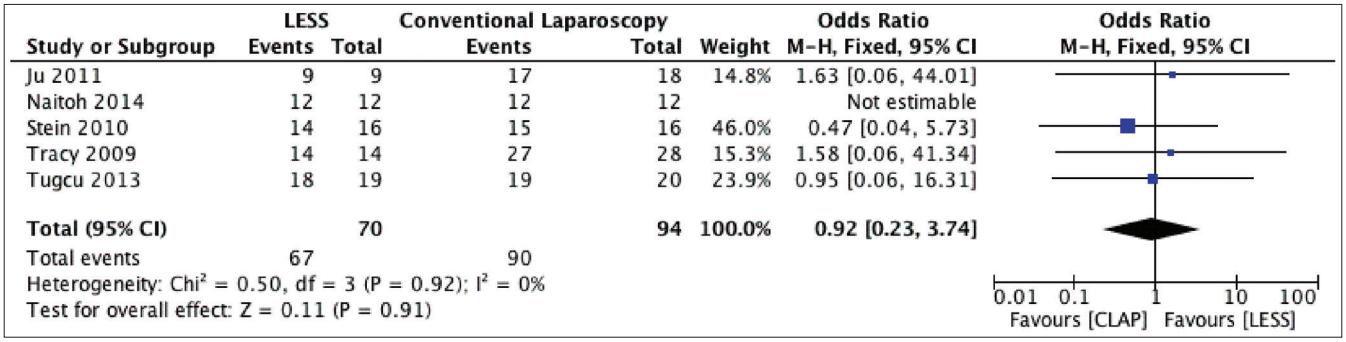

Figure 7: Laparoendoscopic single site versus CLP: Forrest plot of success rate (*n* of cases)

shortened convalescence and improved patient satisfaction with cosmesis.

We systematically reviewed the outcomes of LESS and CLP and a meta-analysis of 5 elected studies between 2009 and 2014 including overall 164 cases. Four of these studies resulted to be of high quality,[13,21-24] according to NOS classification, but with a low LE. The only RCT included in the analysis was a low quality one, as graded by Jadad scale, mainly because the authors described the randomization process, but the patients were not blinded, and there was no mention about withdraws criteria.[25]

As a general principle, all eligible laparoscopic-surgery patients with UPJO may be considered for LESS. On the other hand, although performed by experienced laparoscopic surgeons, in general, patient selection with LESS has been more rigorous than with conventional laparoscopy.[5] In the present analysis, baseline patients' characteristics did not differ significantly between the two groups. Not surprisingly, both LESS and CLP groups included young patients (mean age was < 40 years old), with a low BMI (mean < 30 kg/m^2). Stein *et al.* found a lower BMI in the LESS group (23 ± 6 kg/m^2 vs. 30 ± 7 kg/m^2, $P = 0.002$) and disclosed more strict patient selection criteria for those undergoing LESS.[22] The presence of a crossing vessel was slightly higher, but without statistical significance, in the CLP group (67% vs. 76%; $P = 0.31$). So-called "redo" (secondary) pyeloplasty is recognized as more challenging because of fibrosis and adhesions in the region of the previously operated UPJO. In the comparative studies included in the present analysis, these cases were excluded in order to minimize the risk of complications.

All the procedures were performed transperitoneally using the Anderson-Hynes dismembered technique, which is by far the most commonly adopted and associated with high success rates and low perioperative morbidity.[25] In a recent pooled literature analysis of 776 cases, Wu *et al*. confirmed that the transperitoneal route is associated with a shorter operative time and significantly lower conversion rate compared with the retroperitoneal approach.[26] LESS retroperitoneoscopic Anderson-Hynes pyeloplasty has been reported to be feasible and safe, although technically challenging.[11]

The largest barrier to adoption of LESS is the ergonomic challenge, which can be even more pronounced in the case of pyeloplasty as it is a procedure requiring precise dissection and intracorporeal suturing and reconstruction. Practice patterns indeed demonstrate that urologists report a preference performing extirpative cases with LESS versus reconstructive ones.[5,27] However, the challenges of the technique have been partially overcome with the use of articulating or prebent instruments, different access platforms, and use of needlescopic or minilaparoscopic instruments to facilitate triangulation.[5,28] Stein *et al*. reported using a combination of standard and articulating laparoscopic instruments through a trans-umbilical access where a Triport (ASC, Wickliffe, Ireland) was introduced.[22] Ju *et al*. made a single 2 cm incision at the umbilicus and used a homemade port prepared using an Alexis® wound retractor (Applied Medical, Rancho Santa Margarita, CA, USA) and a glove. Both Ju and colleagues and Stein and colleagues also used an additional 2 mm needlescopic instruments at the subcostal area at the subcostal or right lower quadrant area to facilitate suturing and the ureteral stenting.[21] Tracy *et al*. described employing a "hybrid" operative technique including a single 2.5-cm periumbilical incision with three adjacent 5-mm trocars and an accessory 5-mm lateral trocar to facilitate suturing and to be used a as a drain site at the end of the case. Moreover, they used articulated instruments (Real Hand, Novare Surgical System, Cupertino, CA, USA), and a 45° 5 mm rigid laparoscope.[13] Naitoh *et al*. reported the use of either the Triport (Olympus, New York, NY, USA) or SILS-Port (Covidien, Mansfield, MA, USA) for the LESS cases. In addition, 5-mm flexible scope and 2-mm needlescopic port were used routinely.[24] In the largest multi-institutional report on LESS pyeloplasty to date, Rais-Bahrami *et al*. reported that different LESS access platforms were used as per surgeon preference and of 140 patients included in their analysis, a nearly even distribution of cases (22.9–30.0%) was performed using the GelPoint® (Applied Medical, Rancho Santa Margarita, CA, USA), SILS-Port™ (Covidien, New Haven, CT, USA) and direct fascial incision with or without homemade devices.[28]

Meta-analysis of extractable data showed no significant difference between the groups in terms of operative time (WMD: −7.02; 95% CI: −71.82–57.79; $P = 0.83$), estimated blood loss (WMD: −33.68; 95% CI: −76.16–8.80; $P = 0.12$) and length of hospital stay (WMD: 0.04; 95% CI: −0.11–0.20; $P = 0.58$). Although the estimated blood loss resulted to be statistically significant (WMD: −16.83; 95% CI: −31.79–−1.87; $P = 0.03$) favoring the LESS group, this difference is not clinically relevant. Rais-Bahrami *et al*. reported a mean operative time of 202.1 min with an estimated blood loss of 61.2 mL and length of hospitalization of 2.4 days.[28] When comparing the outcomes of LESS with historic controls in the form of large published series of CLP pyeloplasty, these authors demonstrated comparable perioperative parameters and success rates. Moreover, they highlighted that the range of operative time in their LESS series closely paralleled that of earlier reports of laparoscopic pyeloplasty with similar sample sizes.[29] The same was noted for the length of hospitalization which paralleled that reported for CLP over the past decade.[25]

Autorino *et al*. analyzed the incidence of and risk factors for complications and conversions in a large contemporary series of urological LESS.[30] A total of 120 postoperative complications occurred in 9.4% of cases with major complications in only 2.4% of the entire cohort. Reconstructive procedures ($P = 0.03$), high difficulty score ($P = 0.002$) and extended operative time ($P = 0.02$) predicted high grade complications.

In the present analysis, we found a slightly higher rate of postoperative complications in the LESS group, which was not statistically significant LESS 10% vs. CLP 8.5%; $P = 0.22$). However, two of the included studies reported no postoperative complications in either group.[22,24] The multi-institutional series reported by of Rais-Bahrami *et al*., focusing specifically on LESS pyeloplasty, reported an 18.6% rate of overall postoperative complications was found.[28] Nevertheless, in all these reports most postoperative complications were of low grade (Clavien I-II), which is consistent with our finding in the present analysis.

Best *et al*. focused on 30-day complication rates as an indicator of learning the curve of LESS pyeloplasty by studying 28 cases performed by a single surgeon.[10] Of the patients experiencing complications, 71% were in the first 10 cases, whereas only two complications occurred in the subsequent 18 patients. The authors concluded that LESS pyeloplasty is technically difficult, even for an experienced laparoscopic surgeon, and this may translate to result in a higher complication rate for in the learning curve.

The postoperative use of analgesic (morphine equivalents) favored the LESS group but without reaching statistical significance (WMD: −7.52; 95% CI: −17.56–2.53; $P = 0.14$).

However, pain assessment tools were not homogeneous across studies, and further evidence is needed in order to determine if an advantage exists for LESS.

The definition of success for the pyeloplasty remains controversial. Renal scintigraphy is widely recognized as the best noninvasive technique to assess obstruction of the upper urinary tract objectively.[25] Overall, the success rate was 95.7% for LESS and 95.7% for CLP. These findings mirror the current available literature regarding the failure and success rates for both LESS and CLP.[25,28] Harrow *et al*. recently looked at the functional outcomes at 12 months in a cohort of 31 conventional and 22 robotic LESS pyeloplasties. Severe obstruction ($t/2 > 20$ min) was seen in 32 of 44 (73%) patients at presentation and resolved in ($t/2 \leq 20$ min) in 41 (93% for both groups).[31] Encouraging outcomes even with a longer length of follow-up were reported by Khanna *et al*. for a variety of reconstructive LESS procedures[32]

It is important to emphasize that the robotics surgery is likely to foster LESS surgery, as it holds potential to overcome inherent technical challenges.[33] In a recent analysis, Olweny *et al*. compared the initial single-surgeon experience (10 cases) with robotic LESS pyeloplasty to the latter experience with standard LESS pyeloplasty (10 cases). To minimize the internal and external clashing of the robotic arms, the authors suggested the use of a Gelpoint platform, a 30° upward camera, and pediatric instruments due to their smaller profile. To note, standard LESS pyeloplasty required an accessory port for every case, whereas this was not the case for the robotic cases procedures. The authors suggested that the use of the da Vinci Si platform can shorten the learning curve of LESS pyeloplasty.[34] Cestari *et al*. reported the use of the novel da Vinci Single-Site® instrumentation platform for robotic LESS.[12]

The present meta-analysis has several limitations that must be emphasized. The main limitation is that most of the included studies are retrospective, except for one low-quality RCT. Moreover, the small sample size did not allow achieving statistical significance in most of the assessed parameters. This could be particularly true for those where a 'trend" toward significance was observed (such as for analgesic requirement). However, this remains purely speculative at this time.

While the data on operative time, estimated blood loss and use or of morphine had a high heterogeneity ($I^2 = 96\%$, 96% and 78%, respectively), the length of stay, complications rate and failure rate, demonstrated low heterogeneity ($I^2 = 0\%$, 0% and 0%). One reason for this heterogeneity is the large number of surgeons performing the procedures. In addition, presence or absence of fellows/residents with different levels of experience and the differences in complexity among cases. Furthermore, different techniques were employed. Ultimately, it might be questionable to extract these findings and transfer them into different settings. Moreover, the follow-up period was generally short so that functional outcomes remain to be further explored. Finally, a cost-benefit analysis between LESS and CLP could also be interesting.

Overall, this meta-analysis fills a gap in the current literature on LESS, providing the most up to date information in this area. We decided not to include studies from conference abstracts, and we also did not look for studies in languages other than English. On the other hand, three different search engines were used in order to have a more comprehensive literature search.

CONCLUSION

Current available evidence suggest that LESS pyeloplasty offers comparable surgical and functional outcomes to CLP, while providing the potential advantages of less blood loss and lower analgesic requirement. Thus, despite being more technically challenging, LESS pyeloplasty can be regarded as a minimally invasive approach for patients seeking fewer incisional scars. Ultimately, LESS pyeloplasty should be ideally compared its CLP counterpart within a large, well-designed, prospective, randomized study.

REFERENCES

1. Eden CG. Minimally invasive treatment of ureteropelvic junction obstruction: A critical analysis of results. Eur Urol 2007;52:983-9.
2. Schuessler WW, Grune MT, Tecuanhuey LV, Preminger GM. Laparoscopic dismembered pyeloplasty. J Urol 1993;150:1795-9.
3. Kavoussi LR, Peters CA. Laparoscopic pyeloplasty. J Urol 1993;150:1891-4.
4. Gettman MT, Neururer R, Bartsch G, Peschel R. Anderson-Hynes dismembered pyeloplasty performed using the da Vinci robotic system. Urology 2002;60:509-13.
5. Kaouk JH, Autorino R, Kim FJ, Han DH, Lee SW, Yinghao S, *et al*. Laparoendoscopic single-site surgery in urology: Worldwide multi-institutional analysis of 1076 cases. Eur Urol 2011;60:998-1005.
6. Autorino R, Cadeddu JA, Desai MM, Gettman M, Gill IS, Kavoussi LR, *et al*. Laparoendoscopic single-site and natural orifice transluminal endoscopic surgery in urology: A critical analysis of the literature. Eur Urol 2011;59:26-45.
7. Desai MM, Rao PP, Aron M, Pascal-Haber G, Desai MR, Mishra S, *et al*. Scarless single port transumbilical nephrectomy and pyeloplasty: First clinical report. BJU Int 2008;101:83-8.
8. Kaouk JH, Goel RK, Haber GP, Crouzet S, Stein RJ. Robotic single-port transumbilical surgery in humans: Initial report. BJU Int 2009;103:366-9.
9. Tugcu V, Sönmezay E, Ilbey YO, Polat H, Tasci AI. Transperitoneal laparoendoscopic single-site pyeloplasty: Initial experiences. J Endourol 2010;24:2023-7.
10. Best SL, Donnally C, Mir SA, Tracy CR, Raman JD, Cadeddu JA. Complications during the initial experience with laparoendoscopic single-site pyeloplasty. BJU Int 2011;108:1326-9.
11. Chen Z, Chen X, Wu ZH, Luo YC, He Y, Li NN, *et al*. Feasibility and safety of retroperitoneal laparoendoscopic single-site dismembered pyeloplasty: A clinical report of 10 cases. J Laparoendosc Adv Surg Tech A 2012;22:685-90.
12. Cestari A, Buffi NM, Lista G, Lughezzani G, Larcher A, Lazzeri M, *et al*.

Feasibility and preliminary clinical outcomes of robotic laparoendoscopic single-site (R-LESS) pyeloplasty using a new single-port platform. Eur Urol 2012;62:175-9.
13. Tracy CR, Raman JD, Bagrodia A, Cadeddu JA. Perioperative outcomes in patients undergoing conventional laparoscopic versus laparoendoscopic single-site pyeloplasty. Urology 2009;74:1029-34.
14. Wells GA, Shea B, O'Connell D, Peterson J, Welch V, Losos M, *et al*. The Newcastle Ottawa 1 Scale (NOS) for Assessing the Quality of Nonrandomized Studies in Meta-analyses. Available from: http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp. [Last accessed on 2014 Mar 03].
15. Clark HD, Wells GA, Huët C, McAlister FA, Salmi LR, Fergusson D, *et al*. Assessing the quality of randomized trials: Reliability of the Jadad scale. Control Clin Trials 1999;20:448-52.
16. Phillips B, Ball C, Sackett D, Badenoch D, Straus S, Haynes B, *et al*. Levels of Evidence and Grades of Recommendation. Oxford Centre for Evidence-Based Medicine– Levels of Evidence (March 2009). Available from: http://www.cebm.net/index.aspx?o=1025. [Last accessed on 2014 Mar 03].
17. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 2004;240:205-13.
18. Hozo SP, Djulbegovic B, Hozo I. Estimating the mean and variance from the median, range, and the size of a sample. BMC Med Res Methodol 2005;5:13.
19. Mantel N, Haenszel W. Statistical aspects of the analysis of data from retrospective studies of disease. J Natl Cancer Inst 1959;22:719-48.
20. DerSimonian R, Laird N. Meta-analysis in clinical trials. Control Clin Trials 1986;7:177-88.
21. Ju SH, Lee DG, Lee JH, Baek MK, Jeong BC, Jeon SS, *et al*. Laparoendoscopic Single-Site Pyeloplasty Using Additional 2 mm Instruments: A Comparison with Conventional Laparoscopic Pyeloplasty. Korean J Urol 2011;52:616-21.
22. Stein RJ, Berger AK, Brandina R, Patel NS, Canes D, Irwin BH, *et al*. Laparoendoscopic single-site pyeloplasty: a comparison with the standard laparoscopic technique. BJU Int 2011;107:811-5.
23. Naitoh Y, Kawauchi A, Yamada Y, Fujihara A, Hongo F, Kamoi K, *et al*. Laparoendoscopic single-site versus conventional laparoscopic pyeloplasty: A matched pair analysis. Int J Urol 2014;21:793-6.
24. Tugcu V, Ilbey YO, Sonmezay E, Aras B, Tasci AI. Laparoendoscopic single-site versus conventional transperitoneal laparoscopic pyeloplasty: A prospective randomized study. Int J Urol 2013;20:1112-7.
25. Autorino R, Eden C, El-Ghoneimi A, Guazzoni G, Buffi N, Peters CA, *et al*. Robot-assisted and laparoscopic repair of ureteropelvic junction obstruction: A systematic review and meta-analysis. Eur Urol 2014;65:430-52.
26. Wu Y, Dong Q, Han P, Liu L, Wang L, Wei Q. Meta-analysis of transperitoneal versus retroperitoneal approaches of laparoscopic pyeloplasty for ureteropelvic junction obstruction. J Laparoendosc Adv Surg Tech A 2012;22:658-62.
27. Rais-Bahrami S, Moreira DM, Hillelsohn JH, George AK, Rane A, Gross AJ, *et al*. Contemporary perspectives on laparoendoscopic single-site surgery in urologic training and practice. J Endourol 2013;27:727-31.
28. Rais-Bahrami S, Rizkala ER, Cadeddu JA, Tugcu V, Derweesh IH, Abdel-Karim AM, *et al*. Laparoendoscopic single-site pyeloplasty: Outcomes of an international multi-institutional study of 140 patients. Urology 2013;82:366-72.
29. Jarrett TW, Chan DY, Charambura TC, Fugita O, Kavoussi LR. Laparoscopic pyeloplasty: The first 100 cases. J Urol 2002;167:1253-6.
30. Autorino R, Kaouk JH, Yakoubi R, Rha KH, Stein RJ, White WM, *et al*. Urological laparoendoscopic single site surgery: Multi-institutional analysis of risk factors for conversion and postoperative complications. J Urol 2012;187:1989-94.
31. Harrow BR, Bagrodia A, Olweny EO, Faddegon S, Cadeddu JA, Gahan JC. Renal function after laparoendoscopic single site pyeloplasty. J Urol 2013;190:565-9.
32. Khanna R, Isac W, Laydner H, Autorino R, White MA, Hillyer S, *et al*. Laparoendoscopic single site reconstructive procedures in urology: Medium term results. J Urol 2012;187:1702-6.
33. Autorino R, Kaouk JH, Stolzenburg JU, Gill IS, Mottrie A, Tewari A, *et al*. Current status and future directions of robotic single-site surgery: A systematic review. Eur Urol 2013;63:266-80.
34. Olweny EO, Park SK, Tan YK, Gurbuz C, Cadeddu JA, Best SL. Perioperative comparison of robotic assisted laparoendoscopic single-site (LESS) pyeloplasty versus conventional LESS pyeloplasty. Eur Urol 2012;61:410-4.

How to cite this article: Brandao LF, Laydner H, Zargar H, Torricelli F, Andreoni C, Kaouk J, *et al*. Laparoendoscopic single site surgery versus conventional laparoscopy for transperitoneal pyeloplasty: A systematic review and meta-analysis. Urol Ann 2015;7:289-96.

Source of Support: Nil, **Conflict of Interest:** None.