

## A comparative study of multiport versus laparoendoscopic single-site adrenalectomy for benign adrenal tumors

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### Abstract

**Background** The safety and feasibility of laparoendoscopic single-site (LESS) adrenalectomy for benign adrenal lesions was proved in early clinical series. However, the advantages of LESS over multiport laparoscopic adrenalectomy still are under investigation.

**Methods** Since October 2009, the authors have prospectively performed LESS retroperitoneal adrenalectomy for 21 consecutive patients with benign adrenal tumors (LESS group). Another 28 patients with benign adrenal tumors were prospectively collected between June 2006 and October 2009 and served as a multiport laparoscopic adrenalectomy group. The patients' demographic data, operating time, estimated blood loss, peri- and postoperative complications, and short-term outcome were collected for further analysis.

**Results** The demographic data were comparable between the two groups in terms of the patient age, gender, body mass index (BMI), laterality, diagnosis, and resected

specimen weight. No major complication or mortality occurred in either group. Neither group had any conversions. No differences were observed between the two groups in terms of intraoperative hemodynamic status or peri- or postoperative complications. The LESS patients had quicker resumption of oral intake (0.18 vs 1 day;  $p < 0.001$ ), a shorter hospital stay (2 vs 4 days;  $p < 0.001$ ), and a reduced analgesic requirement postoperatively (0 vs 0.84 mg/kg;  $p = 0.023$ ) than the multiport laparoscopic patients.

**Conclusions** The results demonstrate that LESS adrenalectomy is as safe and effective as conventional multiport laparoscopic adrenalectomy for benign adrenal tumors. In addition, LESS adrenalectomy provides short-term convalescence advantages over multiport laparoscopic adrenalectomy.

**Keywords** Laparoscopy · Adrenalectomy · Laparoendoscopic single-site surgery

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Laparoscopic adrenalectomy has been introduced since the early of 1990s, resulting in reduced postoperative pain and faster recovery. For benign adrenal tumors, laparoscopic adrenalectomy has been regarded as the gold standard of treatment [1]. Although laparoscopic techniques have a lower morbidity rate than the open technique, the laparoscopic technique usually needs four to five trocars because it usually is necessary to retract intraabdominal organs to reach the retroperitoneum [2].

The recent novel technique of laparoendoscopic single-site surgery (LESS) has been performed successfully in various operations including adrenalectomy [2–6]. This novel technique theoretically reduces the multiple-trocar-related parietal trauma and its related complications. Early clinical series demonstrated the feasibility of LESS for benign adrenal lesions [2, 7–12].

Since October 2009, we also have developed a LESS retroperitoneal adrenalectomy technique with our home-made single port and conventional laparoscopic instruments [2]. Although the cosmetic result of LESS is appealing, the clinical outcome advantage of LESS over conventional laparoscopy still is under investigation. The comparative studies investigating the clinical benefits of LESS over conventional laparoscopic adrenalectomy remain sparse [13–15]. Thus, we compare the clinical outcomes between LESS and conventional multiport laparoscopic adrenalectomy.

## Methods

### Patients and methods

Since October 2009, we have prospectively performed LESS retroperitoneal adrenalectomy for 21 consecutive patients (12 men and 9 women, ages 34–74 years) with benign adrenal tumors. These patients served as the LESS group. They experienced functional adenoma ( $n = 11$ ), pheochromocytoma ( $n = 3$ ), and nonfunctioning adrenal tumor ( $n = 7$ ). The patients' demographic data are listed in Table 1.

After the new method had been described and explained, all the patients gave their informed consent to participate in the study. The patients' data, operating time, estimated blood loss, peri- and postoperative complications, and outcome were prospectively collected.

Another 28 patients, (14 men and 14 women, ages 25–71 years) with benign adrenal tumors who had functional adenoma ( $n = 19$ ), pheochromocytoma ( $n = 4$ ), and nonfunctioning adrenal tumor ( $n = 5$ ) were prospectively collected between June 2006 and October 2009. These patients served as a multiport laparoscopic adrenalectomy group. Their demographic data are listed in Table 1.

**Table 1** Demographic data of patients

	LESS group	Multiport group	<i>p</i> Value
Case no.	21	28	
Age: years (range)	50.7 (34–74)	51.7 (25–71)	0.526
Male: <i>n</i> (%)	12 (57)	14 (50)	0.620
BMI (range)	25.6 (20.9–31.3)	24.6 (18–34.2)	0.414
Median no. of incisions: <i>n</i> (range)	1 (1–1)	3 (3–4)	0.006
Preoperative diagnosis			
Functional adenoma	11	19	0.286
Nonfunctional adenoma	7	4	
Pheochromocytoma	3	5	

LESS laparoendoscopic single-site, BMI body mass index

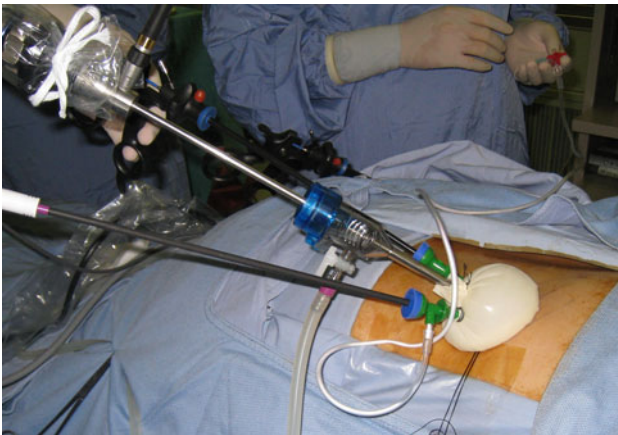
All the aforementioned procedures were performed by two surgeons (Y.-C.T. and V. C.-H. L.) who each had prior experience performing laparoscopic or retroperitoneoscopic adrenalectomy for at least 20 adrenal cases. The inclusion criteria for both groups specified benign adrenal tumor not larger than 6 cm and a solitary metastatic adrenal lesion according to image criteria. We have maintained a prospective database of all operations performed in our departments, including conventional laparoscopic operations, since January 2006. This study is a review of data collected prospectively from this database.

### Operative technique

For multiport laparoscopic adrenalectomy, the patient was placed in flank position. Three or four trocars (10, 5, and 5 mm or 10, 5, 5, and 5 mm) were used for the multiport procedure. The fourth trocar (5 mm) was used for liver or spleen retraction over the subxyphoid incision. The 10-mm trocar was placed para-umbilically, and the remaining 5-mm trocars were placed over subcostal incisions.

After an incision on the peritoneal reflection along the liver edge for a right adrenal lesion or an incision on the white line of Toldt for a left adrenal lesion, the adrenal gland was identified. Once the adrenal vein was secured, the adrenal gland was mobilized from the upper pole of the kidney with hook cautery or ultrasonic scissors. After adrenalectomy, the retrieval bag was placed through the para-umbilical port, and the specimen was extracted.

For LESS retroperitoneal adrenalectomy, the patient was placed in the prone position. The surgeon started the LESS retroperitoneal adrenalectomy with a 2- to 3-cm skin incision just beneath the tip of the 12th rib. With blunt finger dissection, the retroperitoneal space was created for the single-port placement. An Alexis wound retractor



**Fig. 1** The Homemade single port was made of an Alexis wound retractor (Xsmall, Applied Medical, Rancho SantaMargarita, CA, USA), double-layered sterile surgical gloves, and three 5-mm trocars.

(Xsmall; Applied Medical, Rancho Santa Margarita, CA, USA) was placed in position through the incision, and the homemade single port was created [2] (Fig. 1).

After establishment of pneumoretroperitoneum, a rigid 5-mm 30° laparoscope was inserted for inspection of the retroperitoneal cavity. Then two additional 5-mm conventional straight laparoscopic instruments were inserted for subsequent manipulation. Step by step, after creation of the retroperitoneal space by blunt dissection, the upper pole of the kidney was mobilized. Dissection of the adrenal gland progressed from lateral to medial on the back side of the peritoneum to approach the lower portion of the adrenal gland.

For the right adrenal tumors, the adrenal arteries crossing the vena cava medially and posteriorly were separated with bipolar scissors. While the inferior vena cava was visualized posteriorly, the short suprarenal vein was visualized and transected after ligation. Then the right adrenal gland was completely mobilized by lateral and cranial dissection.

For the left-sided adrenalectomy, an extended mobilization of the kidney's upper pole was performed carefully.

Thereafter, the inferior part of the gland could be visualized and dissected. The main left adrenal vein was divided after clipping. After adrenalectomy, the specimen was placed in a retrieval bag and removed through the Alexis wound retractor.

After the procedure, all the patients were encouraged to resume unlimited activity and oral intake as soon as possible. They then were discharged when normal ambulation was resumed. Postoperative analgesics were not routinely provided unless necessary.

#### Statistical analysis

Continuous variables were calculated as the mean or median  $\pm$  standard deviation and compared using the Wilcoxon rank sum test [16]. Differences in categorical and binary variables between the two groups were tested using a two-tailed Pearson chi-square test or Fisher's exact test. All *p* values less than 0.05 were considered statistically significant. Statistical analyses were performed using SPSS for Windows (version 13.0; SPSS, Inc, Chicago, IL, USA).

## Results

#### Patient characteristics

A total of 49 patients (26 men and 23 women) with a mean age of 51 years (range, 25–74 years) who underwent adrenalectomy were evaluated in this study. The baseline demographic data are listed in Table 1. These baseline data were comparable between the two groups in terms of patient age, gender, BMI, laterality, and diagnosis. The median number of skin incisions was 1 in the LESS group and 3 (range, 3–4) in the multiport group ( $p = 0.006$ ). The median weight of the resected specimen was comparable between the two groups ( $p = 0.155$ ) (Table 2).

**Table 2** Surgical outcomes

Median (range)	LESS group	Multiport group	<i>p</i> Value
Operation time (min)	145 (95–292)	95 (30–180)	0.001
Median incidence of perioperative hemodynamic instability (SBP >180 or <80 mmHg): <i>n</i> (range)	0 (0–1)	0 (0–2)	0.681
Specimen weight (g)	18 (8–90)	15 (3–49)	0.155
Estimated blood loss (ml)	Minimal (minimal–600)	50 (minimal–200)	NA
Resumption of oral intake: days (range)	0.18 (0–1)	1 (1–3)	0.000
Hospital stay: days (range)	2 (1–5)	4(2–6)	0.000
Meperidine dosage: mg/kg (range)	0 (0–1.4)	0.84 (0–6.5)	0.023
Complication	0	1 (pneumonia)	1.00
Satisfaction with procedure: <i>n</i> (range)	4 (3–5)	4 (3–5)	0.285

SBP systolic blood pressure,  
NA not available

## Operative results

The LESS group had no laparoscopic or open conversions, and the multiport group had no open conversions (Table 2). The LESS patients had a longer median operative time than the multiport patients (154 vs. 89 min;  $p = 0.001$ ). The incidences of perioperative hemodynamic instability were low and comparable between the two groups ( $p = 0.681$ ). The median estimated blood loss was a little higher in the multiport group than in the LESS group (minimal vs. 50 ml). The LESS patients had a quicker resumption of oral intake (0.18 vs. 1 day;  $p < 0.001$ ), a shorter hospital stay (2 vs. 4 days;  $p < 0.001$ ), and a decreased analgesic requirement postoperatively (0 vs. 0.84 mg/kg;  $p = 0.023$ ) than the multiport group patients.

## Complications

No major complications or mortality occurred in either group. Only one patient in the multiport group had a complication (pneumonia) postoperatively. The overall satisfaction with the surgical wound was comparable between the two groups.

## Discussion

Several early reports confirmed the feasibility and safety of LESS (transperitoneal or retroperitoneal) adrenalectomy for benign adrenal lesions, even pheochromocytomas [2, 7–11]. However, the clinical benefits of LESS adrenalectomy over multiport laparoscopic adrenalectomy still are under investigation. The first comparative study was reported by Jeong et al. [17] in 2009. Until this writing, only four searchable comparative studies had appeared in the literature [13–15, 17]. Most of these comparative studies demonstrated no significant differences between LESS and multiport laparoscopic adrenalectomies in terms of estimated blood loss, hospital stay, or postoperative complications [13, 14, 17]. The operative time was inevitably longer for LESS adrenalectomy because of the technical difficulties derived from instrument clashing in LESS [13–15].

In these studies, the most frequently observed clinical benefit of LESS adrenalectomy was the decreased requirement for postoperative analgesics than with multiport laparoscopic adrenalectomy [13–15, 17]. However, the advantage of a decreased analgesic requirement did not translate into early convalescence. Hence, the clinical benefits of LESS adrenalectomy still are not clear according to the available data except for cosmesis.

In the current trial, we compared the short-term clinical outcomes, including short-term convalescence, between multiport laparoscopic and LESS adrenalectomy for benign

adrenal lesions. As shown in the previous comparative trials, LESS is not superior to the conventional multiport technique in terms of the success and safety of adrenalectomy. The multiport approach appears to be better than the LESS approach in terms of procedure efficacy (shorter operative time) due to (1) the difficulties of crossing manipulation and instrument fighting with LESS [2, 5, 13], (2) the inevitable time consumed creating our homemade single port (average, 15 min) [3], and (3) the learning curve for a novel approach. Although LESS adrenalectomy is as safe and effective as conventional laparoscopic adrenalectomy, the steep learning curve and the manipulation difficulties associated with the single-incision access make LESS adrenalectomy unsuitable for surgeons not experienced with the laparoscopic approach.

Currently, the main controversy in the development of LESS is the increased cost of health care for unproved clinical benefits [5]. Theoretically, the possible advantage of the LESS approach is fewer skin incisions than required by the conventional laparoscopic approach, which might possibly translate into less postoperative pain and even early convalescence. Unfortunately, comparative reports show no convalescence advantage except for two reports describing LESS nephrectomy [18, 19]. The published comparative studies investigating adrenalectomy also suggest that LESS provided few or no clinical benefits in terms of postoperative convalescence [13–15, 17]. In contrast to these trials, our study showed that LESS adrenalectomy was superior to multiport laparoscopic adrenalectomy in terms of oral intake resumption and hospital stay.

To the best of our knowledge, this is the first study to show the convalescence advantages of LESS adrenalectomy over conventional multiport laparoscopic adrenalectomy. Our LESS approach had better convalescence than the multiport laparoscopic approach for the following possible reasons.

1. The decreased number of skin incisions with LESS may have reduced the requirement for analgesics. The common postoperative analgesics such as opioids and non-steroid antiinflammatory drugs usually are associated with bowel dysfunction [20]. With the decreased analgesic requirement after the LESS approach, early resumption of oral intake and ambulation are predictable.
2. The retroperitoneal LESS approach could possibly have decreased the incidence of peritoneal violation compared with the transperitoneal multiport laparoscopic approach, thus resulting in early convalescence.

However, the convalescence advantages of the retroperitoneoscopic approach were not observed in several studies comparing the transperitoneal and retroperitoneal approaches in the literature, including a prospective randomized trial [21–23]. Thus, we confirmed that the early convalescence

advantage of LESS adrenalectomy was primarily a benefit of the reduced requirement for postoperative analgesics.

Our LESS platform had the following advantages over other commercialized LESS products:

1. The average increased expense for LESS consumables (about US\$80 per procedure) were minimal.
2. In LESS adrenalectomy, three trocars on a homemade port usually were sufficient with our retroperitoneal approach. Hence the extra expense for the fourth or fifth trocar commonly used in conventional laparoscopic adrenalectomy was saved.
3. With the currently described LESS technique, further expenses on newer articulating instruments and flexible endoscopic systems rarely were necessary when a standard laparoscopic system and instruments were already available. Hence, LESS could be performed as cost effectively as conventional laparoscopic surgery with the LESS setup.

The major limitation of this study was the inevitable selection bias from a nonrandomized study design. Only prospective randomized clinical trials with longer follow-up periods can clearly answer the question whether LESS adrenalectomy provides significant convalescence advantages over conventional multiport laparoscopic adrenalectomy.

## Conclusions

Our results demonstrate that LESS adrenalectomy is as safe and effective as conventional multiport laparoscopic adrenalectomy. In addition, our short-term results showed that LESS adrenalectomy provided convalescence advantages over multiport laparoscopic adrenalectomy. However, a large-scale prospective randomized study is warranted to provide more solid evidence.

**Disclosures** Victor Chia-Hsiang Lin, Yao-Chou Tsai, Shiu-Dong Chung, Tin Chou Li, Chen-Hsun Ho, Fu-Shan Jaw, Huai-Ching Tai, and Hong-Jeng Yu have no conflicts of interest or financial ties to disclose.

## References

1. Gagner M, Lacroix A, Bolte E (1992) Laparoscopic adrenalectomy in Cushing's syndrome and pheochromocytoma. *N Engl J Med* 327:1033
2. Chung SD, Huang CY, Wang SM, Tai HC, Tsai YC, Chueh SC (2011) Laparoendoscopic single-site (LESS) retroperitoneal adrenalectomy using a homemade single-access platform and standard laparoscopic instruments. *Surg Endosc* 25:1251–1256
3. Tai HC, Lin CD, Wu CC, Tsai YC, Yang SS (2010) Homemade transumbilical port: an alternative access for laparoendoscopic single-site surgery (LESS). *Surg Endosc* 24:705–708
4. Chung SD, Huang CY, Wang SM, et al (2010) Laparoendoscopic single-site (LESS) nephroureterectomy and en bloc resection of bladder cuff with a novel extravesical endoloop technique. *Surg Innov* 17:361–365
5. Tsai YC, Ho CH, Tai HC (2010) Laparoendoscopic single-site (LESS) retroperitoneal nephropexy with standard laparoscopic instruments. *J Laparoendosc Adv Surg Tech A* 20:257–256; discussion 260
6. Tai HC, Ho CH, Tsai YC (2011) Laparoendoscopic single-site surgery: adult hernia mesh repair with homemade single port. *Surg Laparosc Endosc Percutan Tech* 21:42–45
7. Cindolo L, Gidaro S, Neri F, Tamburro FR, Schips L (2010) Assessing feasibility and safety of laparoendoscopic single-site surgery adrenalectomy: initial experience. *J Endourol* 24:977–980
8. Yuge K, Miyajima A, Hasegawa M, et al (2010) Initial experience of transumbilical laparoendoscopic single-site surgery of partial adrenalectomy in patient with aldosterone-producing adenoma. *BMC Urol* 10:19
9. Rane A, Cindolo L, Schips L, De Sio M, Autorino R (2011) Laparoendoscopic single site (LESS) adrenalectomy: technique and outcomes. *World J Urol*. [Epub ahead of print]
10. Yoshimura K, Okubo K, Matsui Y, Nishiyama H, Ogawa O (2011) Laparoendoscopic single-site surgery for left adrenalectomy: standardization of technique. *J Endourol* 25:1031–1035
11. Castellucci SA, Curcillo PG, Ginsberg PC, Saba SC, Jaffe JS, Harmon JD (2008) Single-port access adrenalectomy. *J Endourol* 22:1573–1576
12. Ryu DS, Park WJ, Oh TH (2009) Retroperitoneal laparoendoscopic single-site surgery in urology: initial experience. *J Endourol* 23:1857–1862
13. Ishida M, Miyajima A, Takeda T, Hasegawa M, Kikuchi E, Oya M (2010) Technical difficulties of transumbilical laparoendoscopic single-site adrenalectomy: comparison with conventional laparoscopic adrenalectomy. *World J Urol*. [Epub ahead of print]
14. Shi TP, Zhang X, Ma X et al (2011) Laparoendoscopic single-site retroperitoneoscopic adrenalectomy: a matched-pair comparison with the gold standard. *Surg Endosc* 25:2117–2124
15. Walz MK, Groeben H, Alesina PF (2010) Single-access retroperitoneoscopic adrenalectomy (SARA) versus conventional retroperitoneoscopic adrenalectomy (CORA): a case-control study. *World J Surg* 34:1386–1390
16. Dawson B, Trapp RG (2004) Research questions about two separate or independent groups. In: *Basic & Clinical Biostatistics*, 4th edn, vol 1. pp. 158–159
17. Jeong BC, Park YH, Han DH, Kim HH (2009) Laparoendoscopic single-site and conventional laparoscopic adrenalectomy: a matched case-control study. *J Endourol* 23:1957–1960
18. Park YH, Park JH, Jeong CW, Kim HH (2010) Comparison of laparoendoscopic single-site radical nephrectomy with conventional laparoscopic radical nephrectomy for localized renal-cell carcinoma. *J Endourol* 24:997–1003
19. Canes D, Berger A, Aron M et al (2009) Laparoendoscopic single-site (LESS) versus standard laparoscopic left donor nephrectomy: matched-pair comparison. *Eur Urol* 57:95–101
20. Rosti G, Gatti A, Costantini A, Sabato AF, Zucco F (2010) Opioid-related bowel dysfunction: prevalence and identification of predictive factors in a large sample of Italian patients on chronic treatment. *Eur Rev Med Pharmacol Sci* 14:1045–1050
21. Fernandez-Cruz L, Saenz A, Taura P, Benarroch G, Astudillo E, Sabater L (1999) Retroperitoneal approach in laparoscopic adrenalectomy: is it advantageous? *Surg Endosc* 13:86–90
22. Rubinstein M, Gill IS, Aron M et al (2005) Prospective, randomized comparison of transperitoneal versus retroperitoneal laparoscopic adrenalectomy. *J Urol* 174:442–445 discussion 445
23. Berber E, Tellioglu G, Harvey A, Mitchell J, Milas M, Siperstein A (2009) Comparison of laparoscopic transabdominal lateral versus posterior retroperitoneal adrenalectomy. *Surgery* 146:621–625 discussion 625–626