Laparoendoscopic single-site retroperitoneoscopic adrenalectomy compared with conventional laparoscopy and open surgery

Szu-Han Chena, Chun-Nung Hua, b, Sheng-Chen Wena, Hsin-Chih Yeh a, b, c, d, Hsiang-Ying Leea, Wen-Jeng Wu a, b, c, e, Ching-Chia Lia, b, c, d, *

Objective: Laparoendoscopic single-site surgery (LESS) is a new laparoscopy development that avoids the use of multiple ports and minimizes morbidity. Combined with retroperitoneoscopy, LESS is suitable for adrenalectomy. We compared open, conventional laparoscopic, and LESS-retroperitoneoscopic adrenalectomy (LESS-RA) surgeries for adrenal tumor removal. Furthermore, we analyzed the conventional retroperitoneoscopic adrenalectomy (CRA) and LESS-RA outcomes.

Materials and Methods: We examined 178 patients who underwent adrenalectomy: 43 by open surgery, 72 by conventional laparoscopy, and 63 by LESS-RA. We analyzed the outcomes of operative time, estimated blood loss (EBL), complications, postoperative convalescence, time to resuming oral intake, analgesics on demand, and hospital stay.

Results: We found that the open surgery group had a significantly greater mean EBL than the conventional laparoscopy or LESS-RA group (353.1 ± 313.6 mL vs. 62.3 ± 76.9 mL vs. 60.9 ± 64.3 mL, respectively; p < 0.0001). Open surgery was lengthier than LESS-RA. Both hospital stay and time to resuming oral intake were shortest in the LESS-RA group, followed by conventional laparoscopy and open surgery. CRA and LESS-RA did not differ significantly in mean tumor size, operation time, or EBL. However, there were significant differences in postoperative hospital stay length (6.4 ± 3.4 days vs. 3.6 ± 1.3 days, respectively; p < 0.0001), time to resuming oral intake (1.2 ± 0.5 days vs. 0.4 ± 0.5 days, respectively; p < 0.0001), and number of on-demand intravenous or intramuscular analgesics needed (0.5 ± 0.8 ampoules/vial vs. 0.3 ± 0.6 ampoules/vial, respectively; p = 0.0484).

Conclusion: The standard approach to adrenalectomy recently improved from open to laparoscopic surgery, transperitoneal to retroperitoneal access, and multiple ports to a single port. Here we found that laparoscopic surgery had better intra- and postoperative outcomes than open surgery. Furthermore, patients treated with LESS-RA required less postoperative recovery time and less analgesic use than those treated with CRA.

1. Introduction

Laparoscopic surgery has been shown to result in faster recovery and convalescence, less postoperative morbidity, and better cosmesis than open procedures,1 and it has now practically replaced open surgery in the management of adrenal lesions. Most surgeons agree that it currently represents the standard approach to adrenalectomy.2

As a technical development, the retroperitoneal approach has become popular among urologists for its rapid access to the kidney, renal hilum, and adrenal gland in the retroperitoneal space together with the reduced risk of intra-abdominal organ injury, bowel adhesions, and postoperative ileus.3 Thus, many studies on
The novel laparoendoscopic single-site surgery (LESS) is a further development of laparoscopy in an attempt to prevent multiple scars and minimize port-related morbidities such as bleeding, pain, hernia, and internal organ damage. Many urological procedures have been developed and demonstrated to be feasible and safely performed using LESS. A combination of LESS and retroperitoneoscopic adrenalectomy could be a novel surgery with safer and better outcomes.

In this study, we compared the outcomes of patients undergoing open, conventional laparoscopic surgery with those undergoing LESS-retroperitoneoscopic adrenalectomy (LESS-RA). We also evaluated the results of conventional retroperitoneoscopic adrenalectomy (CRA) and LESS-RA performed by a single surgeon.

2. Materials and methods

Between November 2001 and April 2014, 178 patients with adrenal lesions underwent surgical treatment at Kaohsiung Medical University Hospital, Kaohsiung Municipal Ta-Tung Hospital, and Kaohsiung Municipal Hsiao-Kang Hospital in Kaohsiung, Taiwan. We performed 43 open retroperitoneal adrenalectomy procedures (Group 1), 72 conventional laparoscopic adrenalectomy procedures including intra- and extraperitoneal approaches (Group 2), and 63 LESS-RA procedures (Group 3). The conventional laparoscopic and LESS-RA procedures were performed by a single surgeon.

If the adrenal tumors were > 6 cm, we performed a traditional open retroperitoneal adrenalectomy or a laparoscopic transperitoneal adrenalectomy to ensure a wider operative field. These two different surgical approaches were mainly decided by the surgeon’s experience and the expense that the patient could manage. If the patient had undergone a previous intra-abdominal surgery, we preferred the retroperitoneal approach. For the laparoscopic retroperitoneal surgery, we used the traditional laparoscopic retroperitoneal approach (3 trocar wounds) early on in the study period according to the devices available at each hospital, and then changed to LESS after the introduction of the single-port device and the 5-mm camera scope.

In this study, we collected intraoperative [estimated blood loss (EBL) and operative time] and postoperative (time to resuming oral intake and postoperative stay length) parameters for analysis. During postoperative care, the regular administration of oral diclofenac (25 mg t.i.d.) or acetaminophen (500 mg t.i.d.) was recorded. In addition, data on all parenterally administered analgesics during admission were collected, including nalbuphine, pethidine, morphine, fentanyl, and ketroxolac. The total number of ampoules/vial required by the patient during the hospital stay was calculated. Except for open retroperitoneal adrenalectomy, patients were able to ambulate on the day of the surgery. The patients were discharged when their pain and oral intake were tolerable.

2.1. Laparoscopic operative technique

The conventional transperitoneoscopic adrenalectomy was started with the patient in the standard 60° lateral decubitus position with elevation of the kidney rest and a minimally flexed operation table. The first 12-mm port was inserted in the periumbilical area to accommodate the camera. Two subcostal ports were placed: one (11 mm, right hand) in the midclavicular line and the other (5 mm, left hand) in the lateral border of the rectus abdominis muscle. The third (5 mm, retractor) subcostal trocar was inserted into the anterior axillary line (Figure 1). One must avoid placing these ports too closely together.
was the same as CRA. No drainage tube was placed and the adrenal tumor was removed from the LESS-RA wound.

In the early days of LESS-RA, an Alexis wound retractor (Xsmall; Applied Medical, Rancho Santa Margarita, CA, USA) with homemade sterile surgical glove combining two 10-mm and one 5-mm laparoscopic standard trocars, which was made by the surgeon himself, was used (Figure 3A). Later, a GelPOINT (Figure 3B) was brought in and replaced the endoscopic instruments. Because of the restriction of time-limited usage of GelPOINT, a LAGIPORT set (Figure 3C) was used for entry. Figure 4 shows the 2.5-cm incision wound resulting from the LESS-RA.

2.2. Outcome variables and statistical analysis

The data collected from both groups included age, sex, body mass index (BMI), adrenal tumor laterality, tumor size, operative time, EBL, time to resuming oral intake (days), tumor size, intravenous (IV) or intramuscular (IM) analgesics on demand, and postoperative hospital stay length.

The statistical analysis was performed using SAS version 9.2 for Windows (SAS Institute Inc., Cary, NC, USA). An alpha level of 0.05 was considered significant for all of the statistical procedures. The characteristics of the study participants were presented as means ± standard deviation for normally distributed variables, medians with 25th-75th percentiles for non-normally distributed variables, and frequencies for categorical variables. For the p values, comparisons between the hospitals were performed using analyses of variance, Wilcoxon ranked sum test, or t test. For the categorical variables, the χ² or Fisher’s exact test was performed as appropriate.

3. Results

The patients’ characteristics are summarized in Table 1. There were no significant differences in age, sex, BMI, laterality, or pathological diagnosis of the adrenal tumor among the three groups except for adrenal tumor size. The open approach group had a larger mean tumor size than the conventional laparoscopy and LESS-RA groups (5.8 ± 3.7 cm vs. 3.7 ± 1.6 cm vs. 4.0 ± 1.6 cm, respectively; p < 0.0001). We also performed a subgroup analysis of the whole retroperitoneal laparoscopy approach, including CRA and LESS-RA, and the patient demographic data are outlined in Table 2. Tumor size did not differ significantly between the two groups.

The peri- and postoperative outcomes are summarized in Table 3. Significant differences were seen among the three groups.
Baseline characteristics of patients according to the surgical procedure for adrenalectomy.

<table>
<thead>
<tr>
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<th>Open adrenalectomy</th>
<th>CLA</th>
<th>LESS-RA</th>
<th>p</th>
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<tr>
<td>No. of patients</td>
<td>43</td>
<td>72</td>
<td>63</td>
<td></td>
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<tr>
<td>Age (SD), y</td>
<td>47.3 (14.8)</td>
<td>47.5 (12.5)</td>
<td>50.3 (11.9)</td>
<td>0.3739</td>
</tr>
<tr>
<td>Sex, n (%)</td>
<td>Male 17 (39.5)</td>
<td>28 (38.9)</td>
<td>30 (47.6)</td>
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<td>Tumor side, n (%)</td>
<td>Left 19 (46.3)</td>
<td>38 (52.8)</td>
<td>37 (58.7)</td>
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<tr>
<td>BMI (SD), kg/m²</td>
<td>BM1 (SD), cm</td>
<td>5.8 (3.7)</td>
<td>3.7 (1.6)</td>
<td>4.0 (1.6)</td>
</tr>
<tr>
<td>Time to resume oral intake (d)</td>
<td>2.2 (0.8)</td>
<td>1.3 (0.6)</td>
<td>1.0 (0.5)</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

No conversions to the open approach from the conventional retroperitoneoscopic approach were necessary, and no cases of blood transfusion or mortality occurred in the CRA or LESS-RA group.

4. Discussion

Laparoscopy has become the gold standard surgery for adrenalectomy. Compared with the open approach, laparoscopic adrenalectomy reportedly has less operative blood loss and a lower need for blood transfusion. It also requires parenteral analgesics and features a shorter hospital stay and faster return to daily activities and work.6 Laparoscopic adrenalectomy can be performed by the transabdominal (intraperitoneal) or lumbar (retroperitoneal) approach. We found no significant differences in perioperative or postoperative parameters such as operative time, analgesic dosing requirements, hospital stay, and time to return to normal activities.7 However, compared with the transabdominal approach, the lumbar approach avoided the effects of CO₂ pneumoperitoneum, which might cause respiratory and hemodynamic changes, and allowed us to enter the Gerota’s fascia from the retroperitoneum without touching the intra-abdominal visceral organs. The challenge of the retroperitoneal approach includes abundant and poorly distensible retroperitoneal fat, which impedes the creation of an adequate working space in the retroperitoneum and makes it difficult to maintain orientation in the retroperitoneum due to the lack of visual anatomical landmarks that are normally surrounded by retroperitoneal fat.8

In recent years, a novel surgical technique, LESS, was developed for the purposes of minimizing wound size and reducing morbidity. LESS access could be obtained using a single skin and fascial incision through which a single multichannel access platform is placed (single port) or by the placement of several low-profile ports through separate fascial incisions (single site).9 The former is

<table>
<thead>
<tr>
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<th>Mean (SD)</th>
<th>Mean (SD)</th>
<th>Mean (SD)</th>
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<tr>
<td>Estimated blood loss (mL)</td>
<td>353.1 (313.6)</td>
<td>623.7 (76.9)</td>
<td>609.4 (64.3)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Operation time (min)</td>
<td>140.5 (59.4)</td>
<td>133.3 (51.9)</td>
<td>115.7 (29.4)</td>
<td>0.0206</td>
</tr>
<tr>
<td>Postoperative stays (d)</td>
<td>6.4 (3.0)</td>
<td>3.6 (1.3)</td>
<td>&lt;0.0001</td>
<td></td>
</tr>
<tr>
<td>Time to resume oral intake (d)</td>
<td>2.2 (0.8)</td>
<td>1.3 (0.6)</td>
<td>0.4 (0.5)</td>
<td>&lt;0.0001</td>
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CRA had its own advantage, including a small incision wound, fewer challenging for inexperienced surgeons. Despite these limitations, LESS successful LESS adrenalectomy was published by Cindolo et al\(^{15}\) in 2009.\(^{10,11}\) revealed that LESS was not inferior to conventional laparoscopy and was feasible for urological surgery. This method is now well developed and feasible for a variety of urological Operations.

LESS surgery can be technically difficult because of limitations triangulating the instrument positions. Because all instruments enter through the single port, the surgeon and assistant work in a small space.\(^{12}\) In a previous retrospective analysis, LESS was not found to be superior to laparoscopy.\(^{13}\) The reasons for this included difficulty crossing manipulation, instrument fighting, and novel skills with steep learning curve.\(^{14}\) These factors could be challenging for inexperienced surgeons. Despite these limitations, LESS had its own advantage, including a small incision wound, fewer trocar-related complications, and increased patient safety. The first successful LESS adrenalectomy was published by Cindolo et al\(^{15}\) using the transperitoneal approach. Subsequently, several studies of LESS adrenalectomy have been reported, which shows that this surgery is becoming more widespread.\(^{10,17}\) In the present series, the umbilicus was the most frequently chosen access site for LESS because it has the better cosmetic outcome. However, it was difficult to perform because multiple instruments share a small space and there is a long distance from the incision wound to the adrenal gland, which caused the limited angle of the instrument’s movement and the approach to become increasingly tangential.\(^{18}\)

Accordingly, we used retroperitoneal LESS for the adrenalectomy because it features shorter and safer access. In addition, the retroperitoneal approach was not obstructed by previous abdominal surgery, and the tumor size was the main determinant of wound size. Although some articulating instruments were available to create more working space, we still used conventional instruments for economic reasons.

Because LESS-RA was performed by experienced laparoscopic surgeons in our study, the risk of complications remained low. The conventional laparoscopic and LESS-RA groups had significantly less mean blood loss than the open approach, and none of the patients in these groups needed a blood transfusion during admission. The Clavien system complications in the conventional laparoscopic and LESS-RA groups were not greater than Grade 1. For the aforementioned reasons, laparoscopy has become the gold standard procedure for adrenalectomy.\(^{19}\) For the retroperitoneal laparoscopic adrenalectomy, we did not perform drainage after operation due to the small amount of blood loss. Severe wound pain was rare and the patients required less than a mean of one parenteral analgesic dose during admission.

As in retroperitoneal adrenalectomy, we found that LESS-RA has greater benefits than CRA from several points of view. There are two reasons as to why operative time did not increase in LESS-RA in our study. First, the incision wound of LESS-RA is close to the adrenal gland at the subcostal area from the retroperitoneum. Thus, less time is required to dissect the retroperitoneal fat and identify the adrenal gland. Second, the conventional laparoscopic and LESS-RA procedures were performed by a single surgeon with extensive laparoscopic skill, which shortened the learning curve for technical conversion.

Although no drainage tube was placed in patients treated with CRA or LESS-RA, the total mean size of the surgical wound was smaller in the LESS-RA group. We found that the postoperative parenteral analgesics significantly decreased in the LESS-RA group during admission, which was different from the results of a previous report.\(^{20}\) The major reason was that this study had an increased number of cases in the subgroups analysis. Several published studies reported similar results of less postoperative pain for patients treated with LESS-RA.\(^{10,21}\)

Several published reports showed that patients treated with laparoscopic surgery required less time to resume oral feeding than those treated with open surgery,\(^{22}\) whereas those treated with the retroperitoneal approach resumed oral intake sooner than those treated with the transperitoneal approach.\(^{23}\) Our study also presented a similar result: patients treated with retroperitoneal LESS-RA required less time to resume oral intake than those treated with the retroperitoneal laparoscopic approach. The reason for this could be that, although both procedures approach the adrenal gland by balloon dilatation and the instrument dissecting the retroperitoneal fat, the laparoscopic approach requires a wider dissection area and more working space, which might affect the colon peristalsis. The LESS-RA port location was just beneath the 12th rib to avoid direct contact with the colon. The major concern of time to oral intake in these patients was the anesthetic degrade instead of recovery of bowel peristalsis.

There are some limitations of our study. First, the sample sizes in all groups were small, so further studies with larger populations are needed to compare the procedural effects and outcomes. Second, the ports over the incision wound in the LESS-RA surgery differ, which could influence perioperative parameters such as operative time. Third, the parenteral analgesics were not standardized, meaning that every administration dose had a different pain relief effect. We also did not subgroup the patients by adrenal adenoma type for analysis, and these can influence complication (e.g., pheochromocytoma and Cushing disease), operation time, and hospital stay; besides, it would also need gradual steroid tapering. Finally, in this study, although laparoscopic operations were performed by a single surgeon, the open adrenalectomy was performed by different surgeons. This is the limitation of our study.

Our initial experience shows that LESS-RA is feasible and safe for the treatment of adrenal tumors. Laparoscopy has superior intraoperative and postoperative outcomes to those of open adrenalectomy. Furthermore, compared with CRA, LESS-RA has better postoperative outcomes, including time to oral intake, analgesic use, convalescence, and cosmetic results.
Conflicts of interest

The authors declare that they have no financial or non-financial conflicts of interest related to the subject matter or materials discussed in the manuscript.

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References