Clinical Study

The Optimal Approach for Laparoscopic Adrenalectomy through Mono Port regarding Left or Right Sides: A Comparative Study

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1. Introduction

Since the report of the first pioneering experiences [1], laparoscopic adrenalectomy has become the gold standard for the treatment of benign adrenal tumors. Owing to further development in surgical techniques and instruments, as well as a general increase of interest toward minimally invasive procedures in the past decades, a single incision approach was developed [2] and has been applied to conventional laparoscopic adrenalectomy.

A single incision approach has many advantages compared to conventional procedures, including improved cosmesis, reduced postoperative pain, and quicker convalescence [3]. However, single incision adrenalectomy necessitates more advanced techniques compared with multiport laparoscopic surgery [4, 5]; therefore careful selection of an adequate surgical approach is the key to a successful operation.

The aim of this study was to describe surgical techniques, to analyze the outcomes, and to provide insight on the optimal choice of surgical approach for each individual patient receiving laparoscopic adrenalectomy through mono port (LAMP).

2. Materials and Methods

2.1. Patients. From March 2009 to November 2013, 107 patients underwent laparoscopic adrenalectomy in our institute. Among them, 18 patients received conventional laparoscopic adrenalectomy, respectively. The remaining 89 patients, who received laparoscopic adrenalectomy through mono port (LAMP), were included in our study. All operations were performed by a single surgeon.

All patients received LAMP with either the transperitoneal approach or the posterior retroperitoneal approach, regardless of side. Initially, the surgical approach was chosen according to the tumor size and body habitus of the patient. For patients with tumors larger than 4 cm, BMI over 30 kg/m², or with thick subcutaneous back tissue (thickness
over 4 cm between the skin and Gerota’s fascia), the transperi-
toneal approach was indicated. We selected patients with
tumors less than 4 cm, BMI under 30 kg/m², or with previ-
uous abdominal operations for the posterior retroperitoneal
approach. However, after allocating patients to each approach
according to the selection criteria for 33 cases, due to the small
number of patients with tumors larger than 4 cm (N = 7),
patients with BMI over 30 kg/m² (N = 1), or patients with
abundant retroperitoneal fat (N = 1), an imbalance occurred
between groups, after which patients were randomly selected
to receive each surgical approach, except for patients with
tumors over 7 cm (N = 3), who received LAMP using the
transperitoneal approach.

The surgical outcomes attained using the transperitoneal
and posterior retroperitoneal approaches according to the
right and left sides were analyzed and compared with
respect to tumor size, operation time, time to first oral
intake, postoperative hospitalization time, estimated blood
loss, and postoperative complications. Statistical analysis
was performed using SPSS ver. 18.0, and P values of <0.05 were
considered statistically significant.

2.2. Operation Methods

2.2.1. Laparoscopic Adrenalectomy through Mono Port Using
the Transperitoneal Approach (LAMP-TPA). Under general
anesthesia, the patient was positioned in the lateral (right
or left) decubitus position. The operation table was flexed
just above the level of the iliac crest to maximally widen
the space between the iliac crest and the costal margin for the
best possible port access. After padding all pressure points
(shoulders, elbows, hips, ankles, etc.) to prevent nerve injury
and pressure sores, a bean bag placed under the patient before
surgery was made firm to securely position the patient on the
operation table.

Using preoperative abdominal CT scans, we measured the
length from the adrenal tumor to the umbilicus, and with this measurement as a landmark, the selection of the
optimal incision location was made. Usually, a single 3 cm
incision is made parallel to the lower costal margin, two
fingerbreadths below the costal margin in the midclavicular
line. After opening the peritoneum, an OCTO port (Dalim
Surgnet, Korea) (Figure 1) was inserted into the access site,
and pneumoperitoneum to 15 mmHg was established using
carbon dioxide insufflation.

For the left adrenal gland, the splenic flexure of the colon
and the spleen were mobilized and drawn anteromedially to
expose the retroperitoneum. For the right-sided adrenalect-
omy, after the right lobe of the liver was mobilized, it was
retracted superiomedially with a snake retractor to expose
the adrenal gland and the inferior vena cava. After exposing
the adrenal gland, the feeding vessels were ligated using a
Ligasure (Covidien, Mansfield, MA, USA). The central vein
of the adrenal gland was usually ligated with conventional
laparoscopic clips. After adequate hemostasis, the specimen
was retrieved using a retrieval pouch.

2.2.2. Laparoscopic Adrenalectomy through Mono Port Using
the Posterior Retroperitoneal Approach (LAMP-PRA). Under
general anesthesia, the patient was placed prone in the jack-
knife position, and the operation table was flexed to maximize
exposure of the posterior retroperitoneal space from the
subcostal margin to the iliac crest. A 3 cm sized transverse
skin incision was made one fingerbreadth below the lowest
tip of the 12th rib. The fascia was incised, and the external
oblique, internal oblique, and transversalis muscles were
bluntly divided to expose the retroperitoneal space. After
minimal working space in the retroperitoneum was made for
port insertion, the OCTO port was inserted and CO₂ was
insufflated to 15 mmHg for pneumoretroperitoneum. After
creating adequate working space, Gerota’s fascia was opened,
and the kidney upper pole was mobilized to expose the
adrenal gland. After dissecting the adrenal gland from the
surrounding tissue, the adrenal central vein was identified
and ligated. Finally, the adrenal gland was placed in a pouch
and retrieved.

3. Results

From March 2009 to November 2013, 89 patients underwent
LAMP. Forty-seven patients received surgery for left-sided
adrenal tumors and 42 patients for right-sided tumors. In
cases of left-sided adrenalectomy, the transperitoneal and
posterior retroperitoneal approaches were performed in 26
and 21 patients, and on the left, 19 and 23 patients received
surgery using each approach, respectively. Table 1 shows the
clinical and pathological patient characteristics of all patient
groups.

In cases of left-sided adrenalectomy, there were no sta-
tistical differences regarding patient factors in both groups.
In pathologic diagnosis, one patient in the LAMP-TPA group
was diagnosed with metastatic adenocarcinoma and one
patient in the LAMP-PRA group with metastatic hepatocel-
lar carcinoma.

With regard to adrenalectomies performed on the right
side, no significant differences were found between the two
groups except for patient age (TPA 40.79 ± 5.53 years versus
PRA 50.22 ± 11.61 years; P = 0.002).

The mean tumor sizes of the left-sided groups were
similar (3.28 ± 1.72 cm versus 3.45 ± 2.34 cm; P = 0.779)
(Table 2). However, the LAMP-TPA group had a shorter

Figure 1: OCTO port.
Table 1: Patient characteristics.

|                      | Left (N = 47) | Right (N = 42) | P value | Left (N = 47) | Right (N = 42) | P value |
|----------------------|---------------|---------------|---------|---------------|---------------|---------|
| Patients (N)         | 26            | 21            |         | 19            | 23            |         |
| Sex (N)              |               |               | 0.326   |               |               | 0.327   |
| Male                 | 11            | 9             |         | 15            | 15            |         |
| Female               | 15            | 12            |         | 4             | 8             |         |
| Age (years)          | 48.35 ± 12.26 | 53.38 ± 11.55 | 0.158   | 40.79 ± 5.53  | 50.22 ± 11.61 | 0.002   |
| BMI (kg/m²)          | 23.95 ± 3.35  | 27.28 ± 8.20  | 0.093   | 25.93 ± 2.71  | 25.31 ± 2.99  | 0.489   |
| Diagnosis            |               |               | 0.936   |               |               | 0.509   |
| Primary aldosteronism| 6             | 3             |         | 3             | 5             |         |
| Cushing's syndrome   | 12            | 10            |         | 4             | 8             |         |
| Pheochromocytoma     | 3             | 4             |         | 0             | 0             |         |
| Nonfunctioning tumor | 4             | 3             |         | 12            | 10            |         |
| Others               | 1             | 1             |         | 0             | 0             |         |

LAMP-TPA: laparoscopic adrenalectomy through mono port using the transperitoneal approach, LAMP-PRA: laparoscopic adrenalectomy through mono port using the posterior retroperitoneal approach.

Table 2: Outcomes after surgery.

|                      | Left (N = 47) | Right (N = 42) | P value | Left (N = 47) | Right (N = 42) | P value |
|----------------------|---------------|---------------|---------|---------------|---------------|---------|
| Tumor size (cm)      | 3.28 ± 1.72   | 3.45 ± 2.34   | 0.779   | 2.72 ± 1.57   | 2.61 ± 1.19   | 0.811   |
| Operative time (min) | 83.85 ± 27.72 | 110.95 ± 29.31| 0.002   | 116.84 ± 33.17| 84.13 ± 41.47| 0.008   |
| Time to first oral intake (days) | 1.81 ± 0.49       | 1.10 ± 0.30     | <0.001  | 1.21 ± 0.42   | 1.00 ± 0.00   | 0.042   |
| Length of hospitalization (days) | 3.62 ± 1.02       | 3.57 ± 0.75     | 0.870   | 3.68 ± 1.38   | 2.17 ± 0.39   | <0.001  |
| Estimated blood loss (mL) | 26.15 ± 13.21     | 25.72 ± 12.53   | 0.743   | 24.52 ± 7.48  | 23.28 ± 11.74 | 0.240   |
| Complications        | 1             | 0             |         | 0             | 0             |         |

LAMP-TPA: laparoscopic adrenalectomy through mono port using the transperitoneal approach, LAMP-PRA: laparoscopic adrenalectomy through mono port using the posterior retroperitoneal approach.

Mean operative time was shorter than the LAMP-PRA group, which was shown to be statistically significant (83.85 ± 27.72 min versus 110.95 ± 29.31 min; P = 0.002). In contrast, the average time to first oral intake was shorter in the LAMP-PRA group (1.10 ± 0.30 days versus 1.81 ± 0.49 days; P = 0.001), but there were no differences in hospitalization time (3.62 ± 1.02 days versus 3.57 ± 0.75 days; P = 0.870) and estimated blood loss (26.15 ± 13.21 mL versus 25.72 ± 12.53 mL; P = 0.743) between both groups.

In right-sided adrenalectomies, the mean tumor sizes were 2.72 ± 1.57 cm in the LAMP-TPA group and 2.61 ± 1.19 cm in the LAMP-PRA group (P = 0.811), respectively (Table 2). The LAMP-PRA group had a significantly shorter mean operative time (84.13 ± 41.47 min versus 116.84 ± 33.17 min; P = 0.008). Also, the average time to first oral intake (1.00 ± 0.00 days versus 1.21 ± 0.42 days; P = 0.042) and hospitalization time (2.17 ± 0.39 days versus 3.68 ± 1.38 days; P = 0.001) were shorter in the LAMP-PRA group. Both groups had similar estimated blood losses (23.28 ± 11.74 mL versus 24.52 ± 7.48 mL; P = 0.240).

Regarding complications, one patient in the left LAMP-TPA suffered from postoperative ileus and required longer hospitalization, but no additional postoperative complications were reported in the other groups.

### 4. Discussion

In the search for better patient outcomes, surgery for benign adrenal diseases has gradually changed from the conventional open method to the less invasive methods of laparoscopic adrenalectomy. The laparoscopic approach offers several advantages over open adrenalectomy, such as reduced blood loss, fewer complications, less postoperative pain, and a shorter period of hospital stay [6–8].

To further enhance these advantages, less invasive methods have been introduced, leading to the development of the single incision laparoscopic adrenalectomy [2].

Several studies have shown the feasibility and safety of both transperitoneal and posterior retroperitoneal approaches in single incision laparoscopic adrenalectomy [4, 9–13], but none have compared the outcomes according to the left or right side. Our results show that there may be a difference in surgical results depending on the approach.
selected according to which side the surgery is performed. We propose that the reason for this disparity is due to the anatomical location and characteristics of the adrenal glands.

The left kidney is located approximately between the vertebral level T12 to L3, and due to the asymmetry within the abdominal cavity caused by the liver, the right kidney is slightly lower than the left [14]. Also, the left kidney is typically slightly larger than the right [15]. Both adrenal glands are located superior to the kidneys. The right adrenal gland is pyramidal in shape and lies at the apex of the right kidney. The left adrenal gland has a semilunar shape and lies on the superomedial or anterosuperomedial aspect of the left kidney. On the right side, the liver is located in front of the right adrenal gland, making the anterior margin, which is just separated by the parietal peritoneum. On the left, the spleen with the pancreatic tail makes up the anterior border to the left adrenal gland.

Due to this anatomical presentation, in the posterior retroperitoneal approach, the right adrenal gland is closer with respect to the subcostal margin, and because of its location just superior to the apex of the right kidney, visualization of the adrenal gland is more feasible on the right compared to the left (Figure 2). Also, by using this approach, the right adrenal gland can be directly accessed without mobilization of any intra-abdominal viscera, typically the liver, which can be time consuming and prone to complications.

According to our data, on the right side, the PRA showed statistical significant improvement in operation time compared to the TPA and also demonstrated better postoperative results.

As for the left adrenal gland, however, the retroperitoneal approach can be somewhat challenging. In single incision laparoscopic adrenalectomy, the incision site is limited to the inferior border of the thoracic cage, and it cannot be made directly above the adrenal glands. Thus, in general, the location of the gland is relatively more further from the incision site on the left side. Also, the field of vision and working space are usually narrow [13], and the range of movement is limited by the incision site itself. Due to this difference in surgical depth, a more acute angle is needed to manipulate the gland on the left (Figure 2). Furthermore, direct visualization of the adrenal gland is usually obscured by the apex of the left kidney, so access can only be achieved by excessive retraction of the left kidney during surgery. On the other hand, the TPA, due to the relative familiarity of surgical anatomy to most surgeons, provides a more feasible access to the adrenal gland, even though it requires dissection of the spleen, pancreas tail and splenic flexure of the colon.

According to our data, the operative time was significantly shorter in the LAMP-TPA group on the left side. Postoperative outcomes were similar, although, the time to first oral intake was shorter in the LAMP-PRA group. This was probably due to CO₂ gas insufflation and manipulation of intra-abdominal organs (colon, spleen, pancreas, etc.) which resulted in delayed peristalsis.

There have been some negative views regarding the need for a single incision approach in laparoscopic adrenalectomy, since the conventional approach is feasible and has good outcomes [6–8]. But, in order to evacuate the specimen after conventional laparoscopic adrenalectomy, an additional incision or elongation of the previous incision is needed, which could result in longer operation times and disfigurement of the postoperative wound. After initial trocar insertion in LAMP, however, no further disruption of the wound is needed, resulting in excellent cosmesis (Figure 3). Furthermore, direct visualization of the abdominal layers during opening of the wound as well as identification of the underlying structures during placement of the trocar is possible, which could reduce trocar-related complications. As seen in this study, no wound related complications were reported in all groups, which supports this finding.

5. Conclusion

In conclusion, we report that the LAMP-PRA is a more adequate approach for right-sided single incision laparoscopic adrenalectomies. Although the anterior approach may offer greater familiarity of the anatomy to the surgeon, visibility of
the right adrenal gland is solely achieved through retraction of the liver, which can be avoided with a posterior approach.

For left-sided adrenalectomies, however, we propose that the LAMP-TPA is more suitable. The anatomical location of the left adrenal gland hinders feasible access through the posterior approach. In contrast, the transperitoneal approach provides easier manipulation of the adrenal gland, which could result in better results for the patient.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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