



Comparison of surgical outcomes between lateral and posterior approaches for retroperitoneal laparoscopic adrenalectomy: A single surgeon's experience

Ju Yong Oh¹, Ho Seok Chung¹, Seong Hyeon Yu¹, Myung Soo Kim¹, Ho Song Yu¹, Eu Chang Hwang¹, Kyung Jin Oh¹, Sun-Uck Kim¹, Seung Il Jung¹, Taek Won Kang¹, Kwangsung Park¹, Dongdeuk Kwon¹

Department of Urology, Chonnam National University Medical School, Gwangju, Korea

Purpose: To compare surgical outcomes between the lateral and the posterior approach for retroperitoneal laparoscopic adrenalectomy (RLA).

Materials and Methods: We retrospectively reviewed the records of 130 patients who underwent RLA for adrenal tumors by a single surgeon between January 2015 and December 2018. Patient characteristics and perioperative outcomes were analyzed and compared between two surgical groups: lateral approach (n=56) and posterior approach (n=74).

Results: There were no significant differences in perioperative outcomes between the two groups except for operative time (lateral approach, 105.4±41.21 minutes vs. posterior approach, 71.5±31.51 minutes; p=0.001). In the lateral approach group, two patients (3.6%) underwent open conversion, but there were no major complications in either group (Clavien–Dindo classification ≥3). Male sex was associated with an operative time of ≥90 minutes in the univariate analysis (p=0.019), but this effect did not remain significant in the multivariate analysis. In the multivariate analysis, large tumor size (>5 cm; p=0.020) and preoperative diagnosis of malignancy (p=0.043) were significantly associated with an operative time of ≥90 minutes.

Conclusions: Both the lateral and posterior approaches for RLA were performed safely with similar operative outcomes and are therefore comparable options for the treatment of adrenal tumors. In addition, large tumor size and preoperative diagnosis of malignancy are associated with longer operative times.

Keywords: Adrenalectomy; Laparoscopy; Minimally invasive surgical procedures; Retroperitoneal space

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/4.0>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

Laparoscopic adrenalectomy (LA) was first described in 1992 [1]. Since its development more than two decades ago, LA has replaced the open approach as the standard treat-

ment of choice for adrenal tumors, given the consensus that LA is associated with less postoperative pain, earlier recovery, and similar long-term outcomes compared with open adrenalectomy [2].

Numerous studies have reported on surgical approaches

Received: 12 August, 2019 • **Accepted:** 25 September, 2019

Corresponding Author: Ho Seok Chung ¹ <https://orcid.org/0000-0001-9883-1539>

Department of Urology, Chonnam National University Hwasun Hospital, 322 Seoyang-ro, Hwasun-eup, Hwasun 58128, Korea
TEL: +82-61-379-7745, FAX: +82-61-379-7750, E-mail: hschung615@gmail.com

of LA for adrenal tumors and the associated surgical outcomes. Transperitoneal laparoscopic adrenalectomy (TLA) remains a universal option because of the large working space and familiar surgical anatomy [3]. Retroperitoneal laparoscopic adrenalectomy (RLA) has become a favored procedure owing to decreased operative time, requiring less postoperative care and shorter recovery time [4,5]. Additionally, RLA effectively minimizes postoperative blood loss because of the small space of the retroperitoneum [6]. Several studies have reported that RLA with a posterior approach seems to be superior to TLA and has better perioperative outcomes [5,7]. However, despite being a large-scale comparison of the TLA and RLA approaches, a recent report by the Cochrane research group showed that there are still limitations to choosing a better approach without long-term data on patients, operators, and institutes [8].

To date, the posterior approach has been frequently reported; however, there are few studies on the lateral approach for RLA in the literature, especially compared with other laparoscopic surgical approaches [9-11]. Therefore, the aim of this study was to evaluate the surgical feasibility and to compare the surgical outcomes of the lateral and the posterior approach for RLA from a single surgeon's experience.

MATERIALS AND METHODS

1. Patients

We retrospectively reviewed the data for 130 patients who underwent either the lateral or the posterior approach for RLA by a single surgeon (HSC) at Chonnam National University Hwasun Hospital between January 2015 and December 2018. One surgeon performed RLA with the lateral approach from January 2015 and adopted the posterior approach in December 2016. The lateral approach for RLA was performed exclusively until November 2016. The posterior approach for RLA was performed from December 2016 to December 2018, except in the case of a pregnant patient.

This study was approved by the Institutional Review Board of Chonnam National University Hwasun Hospital (approval number: CNUHH-2018-163). The need for informed consent was waived by the board. According to the guidelines for the management of adrenal tumors and after consultation with the endocrinology department, adrenal tumors were indicated for surgical resection if they were hormonally active or growing during regular evaluation [12,13]. Patients were assessed with respect to demographic and tumor characteristics, such as age, sex, body mass index (BMI), American Society of Anesthesiologists (ASA) score, previous

history of underlying disease, laterality, tumor size based on radiologic findings, and clinical diagnosis.

2. Preoperative evaluation and perioperative care

Preoperative evaluation including the patient's clinical presentation and assessment of biochemical and radiologic parameters were used to make preoperative diagnoses. Regardless of clinical presentation, all patients with adrenal tumors underwent hormonal studies through consultation with an endocrinologist. Routine abdominopelvic computerized tomography and/or magnetic resonance imaging were performed for radiologic examination. Patients diagnosed with pheochromocytoma received alpha-blockers (doxazosin) for at least 2 weeks before adrenalectomy. Patients with uncontrolled hypertension received additional beta-blockers to reach a target blood pressure of 130/85 mm Hg. Metaiodobenzylguanidine scintigraphy was carried out to confirm the presence of extra-adrenal extensions. In patients with primary aldosteronism, spironolactone was prescribed preoperatively. If the patient's blood pressure remained uncontrolled, the spironolactone dose was increased and additional medications were administered. Postoperative pain was evaluated on postoperative days by use of a visual analogue scale (VAS) with scores ranging from 0 (no pain) to 10 (worst pain). Acetaminophen and tramadol hydrochloride were used to relieve postoperative pain in the hospital and at home. Patients routinely returned to a regular diet the day after surgery and were discharged depending on their conditions. Further care such as regular radiologic follow-up, laboratory tests, and oncologic therapy were based on the official pathologic report.

3. Operative technique

For the lateral approach for RLA, the procedure was performed on all patients as previously described [9], after four trocar placements (Fig. 1). For the posterior approach for RLA, the patient's position was changed from supine to prone after intubation. The table was flexed in a jackknife position, allowing for opening of the space between the posterior costal margin and the posterior iliac crest. We used a 3-trocar technique, as shown in Fig. 1. The first incision was made for the camera port, 1.5 cm in length, at the lower tip of the 12th rib. After sufficient retroperitoneal space was made by the finger, the second and third trocars were introduced under the guidance of the index finger over 4 cm medially (lateral to the back muscles, 5 mm) and laterally (lower tip of the 11th rib, 5 or 12 mm) to the first incision point. After all trocars were in their proper positions, the operative procedures were performed in a similar way as the lateral approach for RLA.

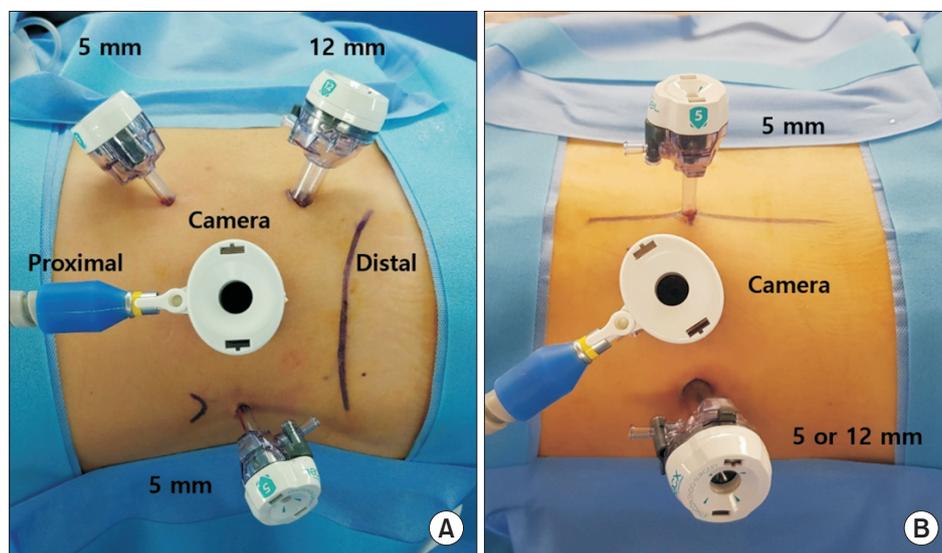


Fig. 1. Port placements in retroperitoneal laparoscopic adrenalectomy for right adrenal tumors. (A) Lateral approach, (B) posterior approach.

In patients with pheochromocytoma, we made an effort to ligate the adrenal vein early in the procedure and reduced manipulation of the adrenal mass to avoid the risk of excessive catecholamine secretion and tumor disruption [9]. A drainage tube was not routinely placed after surgery except with open conversion or for complicated cases and was then removed the day before discharge.

4. Statistical analysis

Patient characteristics and perioperative outcomes were analyzed and compared between the two surgical groups: lateral approach ($n=56$) and posterior approach ($n=74$). Variables were age, sex, BMI, ASA score, previous history of underlying disease, laterality, tumor size, preoperative diagnosis, operative time, change in hemoglobin, rate of conversion to an open procedure, surgical complications, postoperative VAS scores, and postoperative hospital day. Operative time was calculated from the first skin incision to the final stitch of skin closure. The severity of postoperative complications was evaluated based on the Clavien–Dindo classification [14]. Continuous variables were compared using independent Student *t*-tests, and the Pearson chi-square test and Fisher's exact tests were used to compare categorical variables. Univariate and multivariate logistic regression analyses were performed to determine preoperative risk factors for longer operative time (operative time ≥ 90 minutes). Factors with a univariate significance of $p < 0.20$ were placed into multivariate analysis. All data were analyzed using IBM SPSS Statistics version 23.0 (IBM Corp., Armonk, NY, USA). Differences were considered statistically significant at $p < 0.05$.

RESULTS

Demographic data and preoperative characteristics for all patients are summarized in Table 1. The patients' mean age was 53.8 ± 12.7 years, and 71 patients (54.6%) were women. The patients' mean BMI was 25.3 ± 4.2 kg/m². The number of patients with a previous history of hypertension and diabetes mellitus was 89 (68.5%) and 27 (20.8%), respectively. The majority of patients were classified as having an ASA score of I or II ($n=100$, 76.9%). Seventy tumors (53.8%) affected the left adrenal gland. The mean tumor size was 3.14 ± 1.9 cm, and a tumor of 4 cm in diameter or larger occurred in 36 cases (27.7%). Ninety-eight cases (75.4%) of functional tumors underwent surgical resection. Primary aldosteronism was the most common preoperative clinical diagnosis (30%), followed by Cushing's syndrome (17.7%), subclinical Cushing's syndrome (16.2%), pheochromocytoma (11.5%), and malignancy (7.0%). There was no difference in the correlation between the preoperative diagnosis and the official postoperative pathologic report.

Patients were divided into two groups on the basis of surgical approach: lateral approach ($n=56$) and posterior approach ($n=74$) (Table 2). The lateral approach group had more patients with previously diagnosed hypertension ($p=0.011$). There was no significant difference in perioperative outcomes between the two groups except for operative time (lateral approach, 105.4 ± 41.21 minutes vs. posterior approach, 71.5 ± 31.51 minutes; $p=0.001$). Fig. 2 shows the operative time in the lateral and posterior RLA groups according to case number. Cases with an operative time of ≥ 90 minutes occurred more frequently in the lateral approach group than in the posterior approach group (62.5% vs. 31.1%, respectively;

Table 1. Patient demographics and preoperative characteristics

Characteristic	Overall (n=130)	Lateral approach (n=56)	Posterior approach (n=74)	p-value
Age (y)	53.8±12.7	54.0±10.6	53.6±14.2	0.838
Sex				0.835
Male	59 (45.4)	26 (46.4)	33 (44.6)	
Female	71 (54.6)	30 (53.6)	41 (55.4)	
Hypertension	89 (68.5)	45 (80.4)	44 (59.5)	0.011
Diabetes mellitus	27 (20.8)	13 (23.2)	14 (18.9)	0.550
Body mass index (kg/m ²)	25.3±4.2	25.2±4.36	25.4±4.14	0.813
ASA score				0.196
I, II	100 (76.9)	40 (71.4)	60 (81.1)	
III	30 (23.1)	16 (28.6)	14 (18.9)	
Tumor laterality				0.067
Right	60 (46.2)	31 (55.4)	29 (39.2)	
Left	70 (53.8)	25 (44.6)	45 (60.8)	
Tumor size (cm)	3.14±1.9	2.89±1.92	3.32±1.92	0.201
Size ≥4 cm	36 (27.7)	15 (26.8)	21 (28.4)	0.841
Size >5 cm	19 (14.6)	7 (12.5)	12 (16.2)	0.553
Preoperative clinical diagnosis ^a				0.561
Pheochromocytoma	15 (11.5)	5 (8.9)	10 (13.5)	
Malignancy	9 (7.0)	5 (8.9)	4 (5.4)	
Other benign tumors	106 (81.5)	46 (82.1)	60 (81.1)	

Values are presented as mean±standard deviation or number (%).

ASA, American Society of Anesthesiologists.

^a:Preoperative clinical diagnosis is detailed in the manuscript.

Table 2. Comparison of postoperative characteristics between the two groups

Characteristic	Lateral approach (n=56)	Posterior approach (n=74)	p-value
Operative time (min)	105.4±41.21	71.5±31.51	0.001
≥90 minutes operative time	35 (62.5)	23 (31.1)	0.001
Preoperative hemoglobin (g/dL)	13.6±1.59	13.8±1.62	0.357
Immediate postoperative hemoglobin (g/dL)	12.3±1.36	12.5±1.59	0.387
Change in hemoglobin (g/dL)	1.26±0.73	1.30±0.64	0.781
Open conversion	2 (3.6)	0 (0.0)	0.107
Surgical complication			0.373
I	3 (5.4)	2 (2.7)	
II	1 (1.8)	0 (0.0)	
VAS score on postoperative days			
POD 0	2.41±0.91	2.19±0.91	0.161
POD 1	1.29±0.85	1.14±0.63	0.246
POD 2	1.16±0.60	1.08±0.43	0.378
Postoperative hospital stay (d)			0.214
POD ≤2	27 (48.2)	47 (63.5)	
POD 3	23 (41.1)	22 (29.7)	
POD ≥4	6 (10.7)	5 (6.8)	

Values are presented as mean±standard deviation or number (%).

VAS, visual analogue scale; POD, postoperative day.

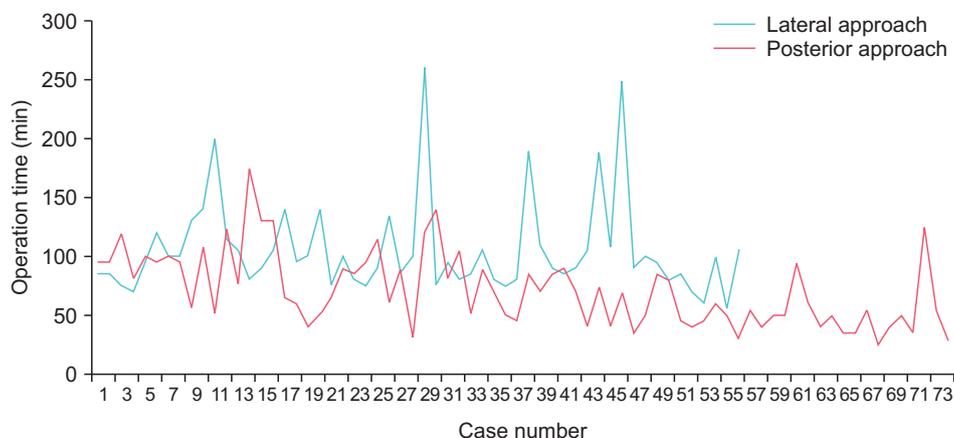


Fig. 2. Operative time for the lateral and posterior approaches for retroperitoneal laparoscopic adrenalectomy.

Table 3. Preoperative clinical factors associated with operative time of ≥ 90 minutes for retroperitoneal laparoscopic adrenalectomy

Characteristic	Univariate analysis		Multivariate analysis	
	OR (95% CI)	p-value	OR (95% CI)	p-value
Age	1.00 (0.971-1.025)	0.870		
Sex				
Female	Reference			
Male	2.34 (1.15-4.74)	0.019	2.10 (0.99-4.45)	0.052
Body mass index	1.06 (0.97-1.15)	0.192	1.04 (0.95-1.14)	0.368
ASA				
I, II	Reference			
III	1.58 (0.70-3.58)	0.275		
Hypertension	1.62 (0.76-3.46)	0.213		
Diabetes mellitus	0.99 (0.43-2.33)	0.984		
Tumor laterality				
Left	Reference			
Right	1.32 (0.66-2.64)	0.430		
Preoperative diagnosis				
Other benign tumor	Reference			
Pheochromocytoma	1.49 (0.23-1.98)	0.472		
Malignancy	4.804 (0.96-24.09)	0.056	5.56 (1.06-29.26)	0.043
Tumor size				
≤ 5 cm	Reference			
> 5 cm	3.18 (1.12-8.99)	0.029	3.57 (1.22-10.43)	0.020

OR, odds ratio; CI, confidence interval; ASA, American Society of Anesthesiologists.

$p=0.001$). In the lateral approach group, two patients (3.6%) underwent open conversions, but there were no major complications in either group (Clavien–Dindo classification ≥ 3). One patient with a grade II complication received a blood transfusion during his hospital stay. All patients returned to a normal diet the day after surgery, with the exception of four patients in the lateral approach group, including two patients with open conversions. Postoperative pain assessment with VAS on postoperative days 0, 1, and 2 showed no significant differences between the two groups ($p=0.214$).

Preoperative clinical factors associated with operative time of ≥ 90 minutes are listed in Table 3. Male sex and large

tumor size (> 5 cm) were associated with longer operative time in the univariate analysis. In the multivariate analysis, preoperative diagnosis of malignancy (odds ratio [OR], 5.56; 95% confidence interval [CI], 1.06–29.26; $p=0.043$) and large (> 5 cm) tumor size (OR, 3.57; 95% CI, 1.22–10.43; $p=0.020$) were significantly associated with an operative time of ≥ 90 minutes.

DISCUSSION

This study is, to the best of our knowledge, the largest report comparing surgical outcomes of the lateral and posterior approaches for RLA. Our study demonstrated that

both approaches were performed safely with similar operative outcomes, and that both approaches were comparable options for the treatment of adrenal tumors. In addition, longer operative time was predicted by several preoperative characteristics, such as large tumor size and preoperative diagnosis of malignancy.

Since LA was first introduced [1], several minimally invasive procedures for the surgical resection of adrenal tumors have been reported. A report by Gill et al. [15] introduced the transthoracic transdiaphragmatic approach for LA in patients with prior major abdominal or renal surgery. Recently, robot-assisted LA was introduced with or without the use of indocyanine green dye with near-infrared fluorescence imaging [16]. According to the generalized surgical approach used worldwide, minimally invasive methods can be divided into TLA and RLA [8]. Several studies that have analyzed surgical outcomes between TLA and RLA have reported that both surgical approaches are comparable and that neither is superior [7,8,17]. Although TLA is used more widely, RLA offers distinct advantages that make it a valuable alternative route to the adrenal gland. RLA has become the more commonly performed surgical approach with some advantages, considering a previous history of abdominal surgery, operative time, risk of surgical herniation, postoperative care, and number of hospital days [5,7,11,18].

To perform RLA for adrenal tumors, surgeons should consider whether to perform the procedure with a lateral or posterior approach, with varied positioning of the patients. The posterior approach for RLA has been reported frequently with or without comparison to surgical outcomes for TLA [8,17-19]. The posterior approach does not necessitate patient repositioning in the case of a bilateral adrenalectomy; however, it requires surgeons to have an understanding of the anatomy in the prone position [7]. In addition, it was previously reported that the posterior approach for RLA seems to have a prolonged operative time with intraoperative risks because a) one cannot easily convert to an open technique rapidly in the case of major bleeding [9] and b) in obese patients the adipose tissue raises intra-abdominal pressure in the prone position, causing the retroperitoneal space to be highly compressed [10]. The majority of urologists are more familiar with the lateral retroperitoneal approach, which is widely used for laparoscopic nephrectomy [2]. However, only a few studies have been reported on the lateral approach for RLA. A study of 800 cases of RLA using the lateral approach reported it to be a safe, effective, technically efficient procedure [11]. Furthermore, our previous studies have demonstrated that the lateral approach for RLA is a safe and feasible treatment option for large adrenal tumors including

pheochromocytoma [6,9]. However, to the best of our knowledge, there has been no study in cases larger than the present study comparing both lateral and posterior approaches in RLA [10].

In the present study, there was no significant difference in perioperative outcomes between the lateral and posterior approach groups except for operative times, and the lateral approach group had more cases with an operative time ≥ 90 minutes than did the posterior approach group. This could have been affected by some complicated cases, including two open conversions in the lateral approach group. One pheochromocytoma patient with a tumor size of 5.6 cm needed to undergo open surgery because of suspicious intraoperative bleeding from the inferior vena cava during dissection of the variant right adrenal vein. In another case, a 10-cm diameter nonfunctional tumor that was attached to vessels and surrounding structures proved to be a hemangioma on the pathologic report. The lateral approach for RLA was used for the case of a 3-cm-wide right adrenal incidentaloma, diagnosed as maternal Cushing's disease, because the patient was 25 weeks' pregnant and had difficulties in the adequate supine position for the posterior approach. In addition, note that most of the patients in the lateral approach group underwent the operation in the first half of the enrollment period. Considering the nature of the learning curves, the operative outcomes reflect an improvement in surgical techniques. As shown in Fig. 2, the operative time of RLA decreased according to case number, which agrees with previous studies about the learning curve for RLA [20,21].

A previous study reported that the lateral approach is advantageous for patients with a high BMI and large tumor size owing to the lack of intra-abdominal pressure compared with the posterior approach [10]. In our study, BMI was not associated with longer operative times. Here, the mean BMI (25.3 ± 4.2) was relatively lower than in previous studies [3,18], possibly because of the differences in BMI between Asian and Western populations [22]. A study that compared lateral transperitoneal adrenalectomy and RLA with a posterior approach showed that male sex and pheochromocytoma were associated with longer operative times [17]. In general, males are more muscular and have greater fat tissue thickness in the retroperitoneum than do females [17,23]. In LA for pheochromocytoma, hemodynamic instability resulting from pneumoperitoneum, tumor manipulation, and difficulty in removing highly vascular tumors could increase surgical complications [9]. However, several studies have shown that LA is a feasible and safe treatment option even for large tumors, and RLA showed shorter operative times than LTA [24,25]. In the present study, being male was associated with

an operative time of ≥ 90 minutes in the univariate analysis, but this effect did not remain significant in the multivariate analysis with pheochromocytoma.

Patients with larger adrenal tumors are known to encounter greater operative difficulties and have a higher risk for malignancies and a higher rate of complications [26,27]. Several studies on large adrenal tumors approximately 5 cm in diameter reported that RLA is an effective procedure [26,28] and seems to be superior to TLA in terms of operative time [28]. Primary and secondary adrenal malignancies are rare. The most common sites of primary malignancy are the adrenal glands, lungs, kidney, colon, and breasts [29]. If a mass is suspected of malignancy, surgeons should decide on an operative technique for complete resection and minimize direct contact with the tumor surface to avoid violating the tumor capsule or causing eruption of disease [29]. Recent studies of adrenalectomy for malignancy, whether primary or metastatic, have reported that minimally invasive adrenalectomy has come to be widely preferred and is a feasible, safe approach in selected patients [19,29]. Similar to the present study, large tumor sizes and preoperative diagnosis of malignancy are significantly associated with longer operative times. Nine cases of adrenal malignancy in this study were patients who had a single metastatic disease and no evidence of local invasion. In addition, there were no cases of capsular disruption or tumor spillage, which was confirmed during the follow-up period.

This study had several limitations. It was a retrospective study conducted by a single surgeon in a single institution. The surgical outcomes could have been influenced by factors related to an individual surgeon's level of experience and the volume of the tertiary center. Furthermore, the patient selection for a specific operative approach depended on the surgeon's preference, meaning that selection bias was unavoidable. However, the surgeries at our institution are performed by an experienced surgical team [6,9], and the patient selection in both groups was done on the basis of time rather than individual preference. A report on LA concluded that surgical experience along with a good team effort has a major role in determining operative results and complications in all surgical procedures [30]. In addition, our study showed similar perioperative outcomes without definite inferiority for both surgical approaches for RLA. Finally, this study was conducted without comparison to other surgical approaches such as the transperitoneal approach or robot-assisted LA. A further randomized controlled study with a large sample size and different surgical techniques is necessary. However, given the lack of previous research in LA for adrenal tumors, this study is important because it focuses

on a unique lateral approach comparing the posterior approaches for RLA.

CONCLUSIONS

The results of our study suggest that both lateral and posterior approaches for RLA were performed safely with similar operative outcomes and are effective treatment options for adrenal tumors. In addition, a large tumor size and a preoperative diagnosis of malignancy are associated with longer operative times.

CONFLICTS OF INTEREST

The authors have nothing to disclose.

ACKNOWLEDGMENTS

This study was supported by a grant (HCRI 19023) Chonnam National University Hwasun Hospital Institute for Biomedical Science.

AUTHORS' CONTRIBUTIONS

Research conception and design: Ho Seok Chung. Data acquisition: Ju Yong Oh, Ho Seok Chung, and Ho Song Yu. Statistical analysis: Ho Seok Chung and Myung Soo Kim. Data analysis and interpretation: Ho Seok Chung and Eu Chang Hwang. Drafting of the manuscript: Ju Yong Oh and Ho Seok Chung. Critical revision of the manuscript: Kyung Jin Oh, Sun-Ouck Kim, Seung Il Jung, Taek Won Kang, Kwangsung Park, and Dongdeuk Kwon. Approval of the final manuscript: all authors.

REFERENCES

1. Gagner M, Lacroix A, Bolté E. Laparoscopic adrenalectomy in Cushing's syndrome and pheochromocytoma. *N Engl J Med* 1992;327:1033.
2. Matsuda T. Laparoscopic adrenalectomy: the 'gold standard' when performed appropriately. *BJU Int* 2017;119:2-3.
3. Lairmore TC, Folek J, Govednik CM, Snyder SK. Improving minimally invasive adrenalectomy: selection of optimal approach and comparison of outcomes. *World J Surg* 2016;40:1625-31.
4. Constantinides VA, Christakis I, Touska P, Meeran K, Palazzo F. Retroperitoneoscopic or laparoscopic adrenalectomy? A single-centre UK experience. *Surg Endosc* 2013;27:4147-52.
5. Kiriakopoulos A, Economopoulos KP, Poullos E, Linos D. Im-

- pact of posterior retroperitoneoscopic adrenalectomy in a tertiary care center: a paradigm shift. *Surg Endosc* 2011;25:3584-9.
6. Hwang I, Jung SI, Yu SH, Hwang EC, Yu HS, Kim SO, et al. Is larger tumor size a contraindication to retroperitoneal laparoscopic adrenalectomy? *World J Urol* 2014;32:723-8.
 7. Lombardi CP, Raffaelli M, De Crea C, Sollazzi L, Perilli V, Cazzato MT, et al. Endoscopic adrenalectomy: Is there an optimal operative approach? Results of a single-center case-control study. *Surgery* 2008;144:1008-14; discussion 14-5.
 8. Arezzo A, Bullano A, Cochetti G, Cirocchi R, Randolph J, Mearini E, et al. Transperitoneal versus retroperitoneal laparoscopic adrenalectomy for adrenal tumours in adults. *Cochrane Database Syst Rev* 2018;12:CD011668.
 9. Chung HS, Kim MS, Yu HS, Hwang EC, Kim SO, Oh KJ, et al. Laparoscopic adrenalectomy using the lateral retroperitoneal approach: is it a safe and feasible treatment option for pheochromocytomas larger than 6 cm? *Int J Urol* 2018;25:414-9.
 10. Agha A, von Breitenbuch P, Gahli N, Piso P, Schlitt HJ. Retroperitoneoscopic adrenalectomy: lateral versus dorsal approach. *J Surg Oncol* 2008;97:90-3.
 11. Zhang X, Fu B, Lang B, Zhang J, Xu K, Li HZ, et al. Technique of anatomical retroperitoneoscopic adrenalectomy with report of 800 cases. *J Urol* 2007;177:1254-7.
 12. Zeiger MA, Thompson GB, Duh QY, Hamrahian AH, Angelos P, Elaraj D, et al.; American Association of Clinical Endocrinologists; American Association of Endocrine Surgeons. The American Association of Clinical Endocrinologists and American Association of Endocrine Surgeons medical guidelines for the management of adrenal incidentalomas. *Endocr Pract* 2009;15 Suppl 1:1-20.
 13. Lee JM, Kim MK, Ko SH, Koh JM, Kim BY, Kim SW, et al. Guidelines for the management of adrenal incidentaloma: the Korean Endocrine Society, Committee of Clinical Practice Guidelines. *Korean J Med* 2017;92:4-16.
 14. Clavien PA, Barkun J, de Oliveira ML, Vauthey JN, Dindo D, Schulick RD, et al. The Clavien-Dindo classification of surgical complications: five-year experience. *Ann Surg* 2009;250:187-96.
 15. Gill IS, Meraney AM, Thomas JC, Sung GT, Novick AC, Lieberman I. Thoracoscopic transdiaphragmatic adrenalectomy: the initial experience. *J Urol* 2001;165(6 Pt 1):1875-81.
 16. Pathak RA, Hemal AK. Intraoperative ICG-fluorescence imaging for robotic-assisted urologic surgery: current status and review of literature. *Int Urol Nephrol* 2019;51:765-71.
 17. Chai YJ, Yu HW, Song RY, Kim SJ, Choi JY, Lee KE. Lateral transperitoneal adrenalectomy versus posterior retroperitoneoscopic adrenalectomy for benign adrenal gland disease: randomized controlled trial at a single tertiary medical center. *Ann Surg* 2019;269:842-8.
 18. Barczyński M, Konturek A, Nowak W. Randomized clinical trial of posterior retroperitoneoscopic adrenalectomy versus lateral transperitoneal laparoscopic adrenalectomy with a 5-year follow-up. *Ann Surg* 2014;260:740-7; discussion 7-8.
 19. Kahramangil B, Berber E. Comparison of posterior retroperitoneal and transabdominal lateral approaches in robotic adrenalectomy: an analysis of 200 cases. *Surg Endosc* 2018;32:1984-9.
 20. Vrieling OM, Engelsman AF, Hemmer PHJ, de Vries J, Vorselaars WMCM, Vriens MR, et al. Multicentre study evaluating the surgical learning curve for posterior retroperitoneoscopic adrenalectomy. *Br J Surg* 2018;105:544-51.
 21. van Uitert A, d'Ancona FCH, Deinum J, Timmers HJLM, Langenhuijsen JF. Evaluating the learning curve for retroperitoneoscopic adrenalectomy in a high-volume center for laparoscopic adrenal surgery. *Surg Endosc* 2017;31:2771-5.
 22. WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet* 2004;363:157-63.
 23. Ito H, Makiyama K, Kawahara T, Osaka K, Izumi K, Yokomizo Y, et al. The impact of gender difference on operative time in laparoscopic partial nephrectomy for T1 renal tumor and the utility of retroperitoneal fat thickness as a predictor of operative time. *BMC Cancer* 2016;16:944.
 24. Shiraishi K, Kitahara S, Ito H, Oba K, Ohmi C, Matsuyama H. Transperitoneal versus retroperitoneal laparoscopic adrenalectomy for large pheochromocytoma: Comparative outcomes. *Int J Urol* 2019;26:212-6.
 25. Li QY, Li F. Laparoscopic adrenalectomy in pheochromocytoma: retroperitoneal approach versus transperitoneal approach. *J Endourol* 2010;24:1441-5.
 26. Wang B, Ma X, Li H, Shi T, Hu D, Fu B, et al. Anatomic retroperitoneoscopic adrenalectomy for selected adrenal tumors >5 cm: our technique and experience. *Urology* 2011;78:348-52.
 27. Henry JF, Sebag F, Iacobone M, Mirallie E. Results of laparoscopic adrenalectomy for large and potentially malignant tumors. *World J Surg* 2002;26:1043-7.
 28. Chen W, Liang Y, Lin W, Fu GQ, Ma ZW. Surgical management of large adrenal tumors: impact of different laparoscopic approaches and resection methods on perioperative and long-term outcomes. *BMC Urol* 2018;18:31.
 29. Kiernan CM, Lee JE. Minimally invasive surgery for primary and metastatic adrenal malignancy. *Surg Oncol Clin N Am* 2019;28:309-26.
 30. Lodin M, Privitera A, Giannone G. Laparoscopic adrenalectomy (LA): keys to success: correct surgical indications, adequate preoperative preparation, surgical team experience. *Surg Laparosc Endosc Percutan Tech* 2007;17:392-5.