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Transabdominal and retroperitoneal adrenalectomy: comparative study

Volodymyr V. Grubnik[1] · Roman S. Parfentiev[1] · Viktor V. Grubnyk[1] · Yurii V. Grubnik[1] · Vladyslav V. Sliepov[1]

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Abstract

Background Laparoscopic adrenalectomy is recognized as the "gold standard" approach for benign adrenal tumors. The majority of surgeons opt for laparoscopic transabdominal adrenalectomies (LTA), while retroperitoneoscopic adrenalectomies (RPA) in the prone position have certain advantages for patients. *The aim* of this study was to compare the effectiveness and safety of the transabdominal and retroperitoneoscopic laparoscopic adrenalectomies.

Materials and methods Between 2000 and 2021, our clinic performed 472 laparoscopic adrenalectomies. The age ranged from 19 to 79 years, with a mean age of 50.5 ± 10.2 years. The patient pool consisted of 315 women and 157 men. Tumor sizes ranged from 1 to 10 cm.

Results In a study of 316 patients undergoing LTA versus 156 with RPA, the TLA averaged 82.5 min (70–98), while the RPA took 56.4 min (46–62) ($P < 0.001$). Intraoperative blood loss was 110 cc for the LTA group and 80 cc for the RPA group ($P < 0.05$) Conversion rates stood at 2.5% for transabdominal and 4.5% for retroperitoneoscopic procedures ($P = 0.254$). At 24 h post-operation, pain scores were 3.6 and 1.6, respectively ($P < 0.001$). Time to resume solid oral intake was 15.2 h for TLA and 8 h for RPA, with hospital stays at 4.5 days and 3 days respectively ($P < 0.001$). Short-term complications occurred in 8.9% of transabdominal and 12.2% of retroperitoneoscopic patients ($P = 0.257$).

Conclusions For small tumors, RPA offers advantages over the transabdominal method in surgery time, blood loss, post-op pain, and recovery. These benefits are enhanced for patients with prior abdominal surgeries. However, large tumors present challenges in the retroperitoneal approach due to limited space and anatomical orientation. If complications emerge, surgeons can seamlessly switch to the LTA.

Keywords Retroperitoneoscopic adrenalectomy · Transabdominal adrenalectomy · Minimally invasive adrenal surgery · Adrenalectomy

Introduction

Adrenal tumors appear in an estimated 0.2–10% of people worldwide [1]. Since 1992, the preferred method of treating small adrenal gland tumors has been laparoscopic adrenalectomy, first performed by the Canadian surgeon Gagner [2]. This procedure generally employs a technique called lateral transabdominal laparoscopic approach. It involves removing either the right or left adrenal gland, depending on the tumor's position, with the patient lying on their side [3].

Another technique, known as the anterior transperitoneal technique, has also been documented in a study by Lezoche et al. [4].

However, carrying out a LTA, especially when removing the left adrenal gland, can be complex. In response to this challenge, Turkish surgeon Selcuk Mercanproposed a different method. This method, a minimally invasive posterior retroperitoneal approach, uses endoscopic techniques and requires the patient to lie face-down on the operating table [5]. Later on, M.Waltz not only popularized but also championed this method [6].While this approach offers some significant advantages over LTA, it is also technically demanding. There is a limited amount of research on this approach, leading to a lack of agreement in the medical literature about its benefits [7, 8].

✉ Viktor V. Grubnyk
vgrubnyk@gmail.com

[1] Odessa National Medical University, Valikhovskiy lane, 2, Odesa, Ukraine

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This study aims to compare the effectiveness and safety of the transabdominal and retroperitoneoscopic laparoscopic adrenalectomies.

Materials and methods

We conducted a retrospective analysis of laparoscopic adrenalectomies performed on 472 patients at our clinic from January 2000 to December 2021.

All operations were performed in the same clinic at the Odessa Regional Hospital, by the same team of surgeons. In the period from 2000 to 2015, we performed LTA, from 2016 to 2021, we performed only RPA.

The patients ranged in age from 19 to 79 years, with an average age of 50.5 ± 10.2 years. The cohort consisted of 315 women and 157 men. Tumor sizes ranged from 1 to 10 cm.

For all patients, adrenal tumors were preoperatively confirmed via abdominal spiral computed tomography (CT) and ultrasound examination. Hormonal activity was assessed in line with the current standards (urinary metoxycatecholamines, cortisol, dexamethasone suppression test, ACTH, DHEAS, blood ions, as well as serum aldosterone concentration, and serum renin activity).

In this study, the criteria for unilateral adrenalectomy included hormonally active adrenal tumors up to 8 cm in diameter, and nonfunctioning adrenal tumors either between 4 and 10 cm in diameter, or smaller tumors demonstrating progressive enlargement on follow-up CT scans (an increase of > 1 cm within 6 months). Patients with pheochromocytoma were preoperatively administered a high-dose alpha-adrenergic blockade (phenoxybenzamine 2–4 mg/kg body weight orally). Patients with aldosteronoma were preoperatively prescribed oral potassium-sparing diuretics and potassium.

Surgical procedures

All procedures in this study were unilateral total adrenalectomies, executed by two seasoned endocrine surgeons under general anesthesia. The same anesthesia protocol was utilized for all patients.

Endoscopic adrenalectomies were conducted as described by Gagner [9, 10]. In LTA, the patients was placed on the operating table in a lateral decubitus position, opposite to the tumor side, with a moderate inclination at the lower ribs level. A pneumoperitoneum was created using a Veress needle for both left and right adrenalectomy, and the CO_2 pressure was maintained at 12 mm Hg. The initial 10 mm trocar was inserted 2 cm below the rib arch in the anterior axillary line, followed by the placement of another 10 mm trocar and a 5 mm trocar at least 5 cm away from the first one, under the ribs. An additional fourth trocar was used for retraction in select left-sided adrenalectomies and in all right-sided adrenalectomies. The peritoneal space was inspected using a 30° laparoscope. After mobilizing the spleen and splenic flexure of the colon or the liver, depending on the operated side, the left renal vein or inferior vena cava was identified. The main adrenal vein was ligated using a bipolar dissecting instrument (LigaSure™, Covidien™). Polymer clips were used in rare cases when vessels exceeded 7 mm. Once completely resected, the adrenal gland along with the surrounding fat was placed in an extraction bag. The operative field was inspected and any visible blood was aspirated. The area was then flushed with warm 0.9% saline solution and aspirated again. Wounds of 10 mm or larger were closed using a laparoscopic port site closure device.

For RPA, the patient was positioned prone on a frame-shaped foam pad, with the lower limbs bent at the hip and knee joints. The procedure began with a skin incision at the tip of the 12th rib, followed by a blunt penetration into the retroperitoneal space. Three trocars, with diameters of 5, 5, and 10 mm, were inserted into the retroperitoneal space. CO2 was insufflated to achieve a pressure of 25 mm Hg. Similar to LTA, RPA was performed using a 30° laparoscope. After penetrating Gerota's fascia, the upper pole of the kidney was identified. The subsequent steps were similar to those in LTA. Drains were inserted in certain patients following the removal of large tumors (those exceeding 6 cm in size).

Outcome parameters

The primary outcome parameter in this study was the surgical duration. The secondary outcomes comprised of intraoperative blood loss, conversion to open surgery rate, intensity of postoperative pain, incidence of shoulder-tip pain, additional requests for analgesia, episodes of nausea and vomiting, the time span to resumption of oral intake, time taken to achieve ambulation, length of hospital stay, and postoperative complications. These complications included the occurrence of long-term surgical access site hernias, the necessity for hernia repair, and for cases involving hormonally active tumors, the biochemical and clinical cure rates were also considered.

Follow-up procedure

Postoperative complications were assessed during hospitalization and at subsequent outpatient department visits scheduled at intervals of 10–14 days, and 1, 3, 12, 24-, 36-, 48-, and 60-months post-surgery. Surgical complications were classified as per the Dindo–Clavien classification [11]. Herniation was evaluated during follow-up visits through a physical examination conducted by the attending surgeons. If there were any indications such as bulging, localized pain

and/or tenderness or any equivocal findings, an ultrasonography using a 7.5 MHz linear-array probe was performed to confirm or exclude the presence of a hernia.

The duration of surgery was measured from the time of skin incision to skin closure. Intraoperative blood loss was estimated based on the hematocrit evaluation in the saline fluid utilized for irrigation, relative to the blood hematocrit. Pain intensity was assessed using the Visual Analog Scale (VAS) at intervals of 6, 12, and 24 h postoperatively. Patients were informed that the scale was intended solely for the analysis of pain intensity, inclusive of any shoulder-tip pain, and did not represent their overall postoperative discomfort. A nurse-controlled analgesia (NCA) protocol was employed in this study, using paracetamol as the standard analgesia, administered intravenously at a dose of 1 g every 6 h, not exceeding 4 g/day. Any additional requests for NCA were recorded, and for such requests, oral ketoprofen was administered at a dose of 0.1 g.

For surgeries involving hormonally active tumors, serum metanephrines, aldosterone, potassium, and cortisol levels were measured. Additionally, blood pressure, the number or dosage of antihypertensive medications, and the requirement for substitution therapy for adrenocortical hormones were evaluated at intervals of 6-, 12-, 24-, and 36-months post-surgery.

The statistical significance of categorical variables was determined using the $\chi 2$ test, while continuous variables were analyzed using the student's t-test. Postoperative pain scores, assessed using the VAS, were treated as parametric data. All statistical analyses were performed using Statistica 8.0 for Windows.

Results

Over a span of 20 years, we performed 472 laparoscopic adrenalectomies. Table 1 presents the demographic and clinical characteristics of patients included in the study. As Table 1 indicates, the group of patients who underwent a RPA was slightly older and had a higher BMI ($P < 0.05$). There were more men in the second group. Additionally, the number of left adrenalectomies was higher in the second group ($P < 0.05$). Both groups had a similar number of hormonally active tumors. However, the incidence of larger tumors, such as myelolipoma and metastatic cancer, was higher in the first group.

In the first group, there was a significant number of patients with large tumors. The distribution of tumor sizes was as follows: 1–2 cm in 110 patients, 3–4 cm in 98 patients, 4–6 cm in 81 patients, and over 6 cm in 27 patients.

Table 1 Characteristics of operated patients with adrenal gland tumors

	1 group, LTA ($n=316$)	2 group, PRA ($n=156$)	P
Men	89 (28.2%)	68 (43.6%)	< 0.05*
Women	227 (71.8%)	88 (56.4%)	< 0.001*
Age, years	48.4 (19–72)	51.2 (28–79)	0.41†
BMI, kg/m^2	29 (16.5–42.3)	28 (18.2–37.8)	0.475†
Tumor localization			
Right	206 (65.2%)	42 (26.9%)	< 0.001*
Left	110 (34.8%)	114 (73.1%)	> 0.05*
Type of tumors			
Pheochromocytoma	84 (26.6%)	59 (37.8%)	0.012*
Aldosteroma	52 (16.5%)	38 (24.4%)	0.039*
Corticosteroma	27 (8.5%)	22 (14.1%)	0.062*
Incidentaloma	124 (39.2%)	29 (18.6%)	6.516*
Myelolipoma	8 (2.5%)	6 (3.8%)	0.428*
Metastatic cancer	21 (6.7%)	2 (1.3%)	0.010*
Tumor size, cm	5.2 (1.7–10.0)	4.0 (1.0–8.0)	< 0.001†
Previous abdominal surgery			
Upper open abdominal operation	8 (2.5%)	15 (9.6%)	< 0.001*
Lower open abdominal operation	14 (4.4%)	6 (3.8%)	> 0.05*
Upper laparoscopic abdominal operation	7 (2.2%)	8 (5.1%)	> 0.05*
Lower laparoscopic abdominal operation	10 (3.2%)	5 (3.2%)	> 0.05*

Values are presented as means unless specified otherwise; Values in parentheses represent 95% CI unless stated otherwise

*χ^2 test

†t test

Among those who underwent RPA, the size distribution was: 1–2 cm in 96 patients, 3–4 cm in 39 patients, 4–6 cm in 18 patients, and over 6 cm in 3 patients.

For patients who had undergone previous abdominal surgery, the RPA procedure was used more frequently.

Table 2 presents the results of the different approaches to laparoscopic adrenalectomies. The duration of operation was shorter for the RPA group (56.4 vs 82.5 min, $P < 0.01$). Blood loss was minimal in both groups, but lower in the RPA group (80 vs 110 cc, $P < 0.05$).

The frequency of conversion was slightly higher in the RPA group (4.5 vs 2.5%). However, conversion in the RPA group occurred in 6 patients due to large tumor sizes and in one patient due to bleeding from the left adrenal vein. In all cases, we switched from the RPA approach to the LTA. Among the LTA patients, there were 8 conversions: 4 due to heavy adhesions in the abdominal cavity after previous operations, 2 due to large tumor sizes, and 2 due to spleen damage and tail of pancreas injury during transabdominal adrenalectomy. In all cases, we converted to open procedures. Thus, conversions after RPA were less traumatic and devoid of serious complications.

Postoperative pain was significantly less in the RPA group (Table 2). Shoulder-tip pain was more frequent and severe in the LTA group. Recovery was quicker after the RPA approach, with patients resuming eating on the day of the operation. The incidence of nausea and vomiting was lower in the RPA group. The rate of complications did not differ significantly between the two groups.

Normalization of functional tests in patients with hormonally active tumors was comparable in both groups and exceed about 80% in both groups of patients. There were now hernias in the group of patients after RPA. After LTA herniation was identified in 4 patients who underwent surgical hernia repair.

According to the histological examination, the distribution by tumor type was as follows: incidentaloma (32.5%), pheochromocytoma (30.2%), aldosteronoma (19%), corticosteroma (10.3%), myelolipoma (3%), and metastatic cancer (5%).

Discussion

The laparoscopic approach in adrenalectomy has been widely accepted as the standard of care due to its minimal invasive nature, which is less traumatic compared to open surgeries [5, 12–15]. Our investigation, in alignment with previous reports, confirms the safety and efficacy of this technique. The comparison between the retroperitoneal and transperitoneal laparoscopic adrenalectomies performed in

Table 2 Primary and secondary outcomes

	1 group, LTA ($n=316$)	2 group, PRA ($n=156$)	P
Duration of surgery, min	82.5 (70–98)	56.4 (46–62)	< 0.001
Intraoperative blood loss, cc	110 (75–200)	80 (60–120)	< 0.05
Conversion, No. (%)	8 (2.5%)	7 (4.5%)	0.254†
Postoperative pain at rest, points (VAS)			
6-h postoperatively	5.2 (3–7)	2.8 (2–4)	< 0.001‡
12-h postoperatively	4.8 (3–6)	2.4 (1–4)	< 0.001‡
24-h postoperatively	3.6 (2–5)	1.6 (1–3)	< 0.001‡
Shoulder-tip pain after surgery, No. (%)*	96 (30.4%)	1 (0.6%)	< 0.001‡
Nausea, No. (%)	89 (28.2%)	31 (19.9%)	< 0.001†
Vomiting, No. (%)	48 (15.2%)	9 (5.8%)	< 0.001†
Time to oral intake of solid diet, h	15.2 (14–15.5)	8 (7.5–9)	< 0.001‡
Length of hospital stay, d	4.5 (4–5)	3 (2.5–4)	< 0.001‡
Surgical complications (short-term), No. (%)	28 (8.9%)	19 (12.2%)	0.257†
Grade I	9	14	0.005†
Grade II	14	5	0.104†
Grade III	3	0	0.140†
Grade IV	0	0	1.000†
Grade V	0	0	1.000†

Postoperative pain was assessed on visual analog scale (0: no pain, 100: maximum pain); Values are presented as means unless stated otherwise; Values in parentheses represent 95% CI unless specified otherwise

*Surgical complications according to Dindo–Clavien classification

†χ^2 test

‡t test

three prospective studies revealed no significant divergence [16–18].

The proposition of the retroperitoneal approach by Walz, a German surgeon, and its application by Polish surgeons have led to a compelling discourse. Although it is not explicitly established whether the retroperitoneal interventions are less traumatic than transabdominal ones, the complexity of anatomical landmarks has been a hindrance to many surgeons [19, 20].

In our study, we present strong evidence supporting the distinct benefits of the RPA in certain cases. A significant advantage of RPA includes the elimination of the need for intra-abdominal dissection of neighboring organs and adhesions to expose the adrenal gland, as this technique allows direct access to the retroperitoneum [19, 21, 22].

Among patients who underwent LTA, conversions were required in 4 patients due to dense adhesions following prior abdominal surgeries. Conversely, although 21.8% of patients undergoing RPA had a history of previous abdominal surgeries, there were no conversions necessitated by adhesions. This suggests that RPA could be an advantageous choice for patients with a history of abdominal surgeries [23, 24].

Avoidance of intraabdominal dissection in RPA led to a shorter operative time compared to the LTA group ($P < 0.001$). There was also a notable reduction in blood loss (80 vs 110 cc, $P < 0.05$) [25]. The primary advantage of the RPA approach was the faster and less painful recovery. Remarkably, patients were able to ambulate and consume solid foods on the day of surgery itself [26]. Patients in the RPA group experienced significantly less shoulder-tip pain postoperatively, along with fewer instances of nausea and vomiting. The length of hospital stay was shorter for RPA patients (3 vs 4.5 days, $P < 0.001$) [22, 26].

The direct access to the retroperitoneum provided by the RPA technique via trocar port placement in the lumbar region was correlated with a nullified risk of surgical access site herniation and subsequent hernia repair. In a 3-year follow-up, no herniations were noted in the RPA patient group. In contrast, herniation was observed in the LTA group, particularly in patients with a BMI above 30 kg/m^2 and larger tumors necessitating an expanded abdominal incision for removal [21, 22].

Acknowledging the potential limitations of our study, it is a retrospective, non-blinded design implemented at a single institution. Nevertheless, our large patient cohort undergoing laparoscopic adrenalectomy offers persuasive evidence supporting the retroperitoneal approach's merits, notably for patients with small adrenal tumors ranging from 1 to 4 cm in size. For larger tumors exceeding 6 cm, our data suggests the LTA approach is preferable.

One significant observation is the extended "learning curve" associated with the RPA, which some surgeons argue requires the execution of at least 20 operations to achieve proficiency. This extended learning phase must be taken into account when considering this surgical approach [20, 27, 28].

Despite its potential limitations, such as demographic discrepancies within the patient groups that could introduce bias, the potential influence of surgeons' learning curves on operative outcomes, and unequal patient cohort sizes, our study delivers valuable insights. The robustness of our study stems from its extensive clinical data, a substantial postoperative observation period, and diverse surgical experience with different types and sizes of tumors in both left and right adrenal glands.

While our findings should be interpreted with these limitations in mind, we believe that our study offers significant insights into adrenal surgery, specifically the benefits of RPA in managing small adrenal tumors. It provides a foundation for future research to further refine surgical technique selection based on tumor size, patient history, and other individual characteristics.

Although the RPA exhibits clear advantages, it also has its limitations, meaning it cannot entirely supplant the LTA approach. As such, it is pivotal that both techniques are included in the surgical repertoire of surgeons routinely performing adrenalectomies. This diverse armamentarium enables surgeons to tailor the surgical approach to individual patient characteristics and tumor specifics.

Indeed, the success of minimally invasive adrenal surgery hinges on several critical factors. First, a strong foundation in endoscopic surgery is crucial, allowing surgeons to proficiently navigate the complexities of these minimally invasive techniques. Secondly, careful patient selection, taking into account the patient's medical history, the size and location of the tumor, and other individual characteristics, is key in determining the most appropriate surgical approach. Lastly, a high patient volume can contribute to enhancing the surgeon's expertise and skill, thereby reducing complications and enhancing patient outcomes [29].

Conclusions

For small tumors, retroperitoneal adrenalectomy showed significant benefits over the transabdominal method in surgery duration, blood loss, postoperative pain, and recovery time. For patients with a history of abdominal surgeries, the benefits of the retroperitoneal method are further amplified. However, managing a large tumor via the retroperitoneal approach can pose challenges due to the small size of the space and technical problems with anatomical orientation. Despite, if complications arise during the retroperitoneal procedure, surgeons can transition to the laparoscopic transabdominal approach.

Declarations

Disclosures Viktor V. Grubnyk, Volodymyr V. Grubnik, Yurii V. Grubnik, Vladyslav V Sliepov and Roman S. Parfentiev have no conflicts of interest to disclose.

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