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## A Comparison of Two Approaches to Laparoscopic Adrenalectomy: Lateral Transperitoneal Versus Posterior Retroperitoneal Approach

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### Abstract

**Background.** Laparoscopic adrenalectomy is the gold standard for the surgical treatment of benign adrenal masses. It is most commonly performed using the lateral transperitoneal approach (LTA) and the posterior retroperitoneal approach (PRA). The choice of the method depends on contraindications for a particular approach in an individual case and surgical experience. The objective of the article is to compare two approaches, LTA and PRA, in view of our own experience and literature review.

**Objectives.** The objective of the article is to compare two approaches, LTA and PRA, in view of our own experience and literature.

**Material and Methods.** The assessment involved morphological characteristics of tumors, indications for PRA and LTA, operative time, perioperative blood loss and postoperative complications.

**Results.** Seventy-seven of the examined 104 laparoscopic adrenalectomies were performed retroperitoneally; 27 – transperitoneally. The mean size of tumors in PRA was 4.6 cm and in LTA 6.2 cm. The mean total operative time was 91.8 min in the case of PRA and 153.1 min in LTA. No differences in the amount of blood loss between the two approaches were recorded. The average hospitalization post PRA lasted 2.03 days and post LTA 2.67 days.

**Conclusions.** Laparoscopic adrenalectomy proves to be an effective and safe surgical technique both in the case of LTA and PRA. The technique to be used should be suited to surgical team's experience, patient's general condition and tumor size and location. In our experience, the most advantageous approach in the case of tumors of less than 7 cm is PRA (Adv Clin Exp Med 2016, 25, 5, 829–835).

**Key words:** adrenalectomy, laparoscopic, transperitoneal, retroperitoneal adrenalectomy.

Surgery has recently made immense progress towards the minimization of invasiveness. Surgical trauma and the rate of complications have been limited significantly. As a result, decreased postoperative pain, shorter hospital stay, faster recovery, reduced mortality, improved cosmetic effect and decreased hospital costs have been observed [1, 2]. Various studies conducted worldwide confirm the safety and efficacy of interventions that employ novel methods also in patients diagnosed with car-

diovascular and respiratory diseases, or those with obesity [1]. However, novel methods may prolong operative time when employed by trainee surgeons.

During surgical procedures, the proper exposure of paired adrenal glands is challenging due to their small size, fragility and localization in the retroperitoneal area (deep inside the adipose tissue). Classical interventions require extensive incisions through integuments that are disproportionately large compared to the size of the glands [3].

Therefore, after the publication of the first report of laparoscopic adrenalectomy in 1992 by Gagner et al., the technique became the gold standard for the treatment of benign tumors of less than 6 cm [1, 3, 4]. It is mostly used to remove adenomas causing Conn's syndrome and Cushing's syndrome, as well as hormonally-inactive tumors, pheochromocytomas or incidentalomas. Pheochromocytoma patients had been excluded from videoscopic treatment for a long time due to perioperative complications, i.e. haemodynamic disorders due to excessive manipulations [5]. Currently, the minimally invasive adrenalectomy is successfully used in more than 90% of pheochromocytoma cases, preceded by preoperative pharmacotherapy to inhibit the hormonal activity of the tumor [6–9].

Thanks to technological progress, laparoscopic adrenalectomy is becoming more common in the treatment of tumors > 6 cm [10]. Tumors of more than 12 cm in diameter and malignant lesions infiltrating other tissues should be operated using conventional approaches [3, 7]. In the case of malignant non-infiltrating tumors of 4 to 6 cm, both open and minimally invasive approaches to adrenalectomy are acceptable [11]. In the case of a metastatic disease, laparoscopic technique is a standard procedure as long as a negative surgical margin is available [12]. However, it may still be necessary to use the conventional approach if any difficulties occur during the procedure. Therefore, the resection of either primary or secondary malignant adrenal tumors requires considerable experience of the surgeon [13, 14].

Several laparoscopic approaches can be used. Among the most common methods are the lateral transperitoneal approach (LTA) and the posterior retroperitoneal approach (PRA) [10]. The method used depends mainly on the surgeon's preference and contraindications, if any, for a particular approach in the patient. LTA allows easier removal of some large adrenal gland tumors in non-typical locations [15]. On the other hand, in PRA the adrenal gland is directly accessible even without the mobilization of intraperitoneal organs. Moreover, adhesions can be avoided in patients with previous abdominal interventions, and the surgeon can treat bilateral tumors simultaneously, without changing position [16]. In the available reports, PRA features a shorter operative time, reduced blood loss, shorter hospitalization, comparable rate of complications, and, according to some authors, shorter learning curve, as compared with LTA [16–19].

The objective of the study was to compare the two most common approaches to laparoscopic adrenalectomy, i.e. LTA and PRA, based on literature review and own experience. Additionally, data regarding open procedures from the same period is shown.

## Material and Methods

### Material

The study included 104 patients of the 1<sup>st</sup> Department of General and Endocrine Surgery, Medical University of Białystok, subjected to an adrenalectomy from February 2010 to February 2015. The interventions were preceded by biochemical marker testing, evaluation of the functional status of adrenal glands, and diagnostic imaging (ultrasound scanning and computed tomography). All patients with suspected adrenal carcinoma or a tumor larger than 10 cm were qualified for the conventional method, and thus excluded from the study. The surgery was performed in 61 females and 43 males aged 23–79. The LTA approach was used in 27 cases and the PRA approach was used in 77 cases. The LTA and PRA patient groups were reviewed and compared with respect to their clinicopathologic characteristics and surgical outcomes.

The obtained parametric data (characterized by normal distribution) is presented as mean  $\pm$  standard deviation (min and max age of the patients is also included). Non-parametric data is presented as median and the min–max range. The statistical analysis of the parametric data involved the ANOVA test, while that of the non-parametric data involved the Kruskal-Wallis version of the ANOVA test and the  $\chi^2$  test. The results were considered statistically significant at  $p < 0.05$ . The statistical analyses were conducted using STATISTICA v. 10.0.

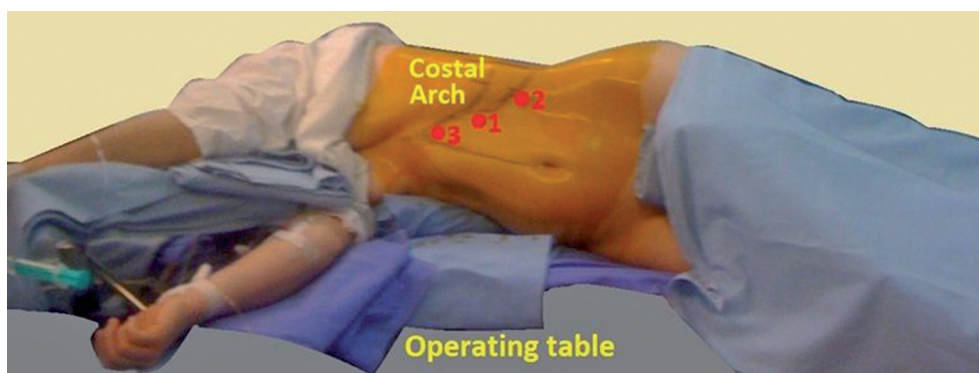
## Surgical Methods

### Lateral Transperitoneal Approach

The patients were placed in a lateral position, with the affected side facing upwards. A 10-mm trocar was inserted 3–4 cm subcostally, at the extension of the midclavicular line, followed by insufflation of CO<sub>2</sub> to 12–15 mm Hg. Subsequently, two 5-mm trocars were introduced 5–8 cm laterally to the optical trocar (Fig. 1).

**Left adrenalectomy:** An incision of the spleno-renal and spleno-diaphragmatic ligaments was made to expose the adrenal gland. Subsequently, the left adrenal gland vessels were secured and the left adrenal gland was dissected from the kidney.

**Right adrenalectomy:** An additional 5-mm trocar was placed to allow liver retraction. The adrenal gland was dissected from the side of the liver and a liver retractor was introduced. The right kid-



**Fig. 1.** Patient positioning for left adrenalectomy using laparoscopic transperitoneal approach (LTA). (Photo by P. Myśliwiec)

ney was identified. After the exposure of the inferior *vena cava*, it was necessary to identify and precisely secure the central adrenal vein, arteries and extra right adrenal veins. Finally, the right adrenal gland was dissected and removed.

### Posterior Retroperitoneal Approach

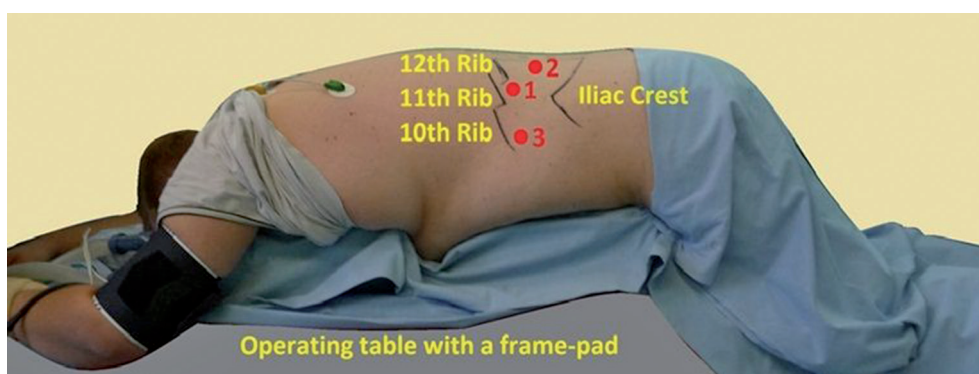
The patients were anaesthetized, intubated on the trolley, and placed on the operating table in the prone position, on a rectangular foam frame. The patients' legs were flexed at the hip and knee joints, forming an incomplete right angle. Retroperitoneal access was bluntly created by means of a 2-cm incision at the tip of the 12<sup>th</sup> rib. A 10-mm trocar was then inserted paravertebrally under guidance of the index finger, approx. 3–4 cm beneath the 12<sup>th</sup> rib, at a 45° angle. Subsequently, a 5-mm trocar was placed below the 11<sup>th</sup> rib, approx. 6 cm laterally (Fig. 2). A trocar with a balloon to prevent gas escape was introduced into the initial wound, followed by CO<sub>2</sub> insufflation to 20–28 mm Hg [19]. The initial part of the tumor-affected adrenal gland dissection procedure in-

involved determining the upper renal pole. The dissection was directed medially, between the crura of the diaphragm and the adrenal gland. The vessels were dissected and sealed. Finally, the adrenal gland with the tumor was dissected free and disposed of in an extraction bag.

### Results

One hundred-four laparoscopic adrenalectomy procedures were performed in the study period, with 77 procedures employing the PRA approach and 27 procedures employing the LTA approach. The mean result of the ASA physical status classification system was 2.5 (ranging from 2 to 4). The mean BMI of the patients subjected to PRA was 30.4, and that of the patients subjected to LTA was 28.8. The majority of the procedures (94%) were performed by one surgeon either as PRA or LTA.

All study interventions were primary surgeries. Hormonally inactive tumor was the prevalent preoperative diagnosis (Table 1). In 51% cases, the tumor affected the left adrenal gland, and in the remaining 49% the tumor affected the right adre-



**Fig. 2.** Patient positioning for left adrenalectomy using posterior retroperitoneal approach (PRA); 1, 2, 3 – trocar sites in the range of their introducing. (Photo by P. Myśliwiec)

**Table 1.** Patients' characteristics

	PRA (n = 77)	LTA (n = 27)	p-value
Age $\pm$ SD (range)	58.8 $\pm$ 10.4 (23–79)	53.6 $\pm$ 11.5 (28–75)	ns.
Sex:			ns.
male	32 (42%)	11 (41%)	
female	45 (58%)	16 (59%)	
BMI $\pm$ SD	30.4 $\pm$ 3.8	28.8 $\pm$ 4.9	ns.
ASA median (min–max)	2 (2–4)	3 (2–4)	ns.
Tumor size $\pm$ SD	4.6 $\pm$ 1.4	6.1 $\pm$ 2.1	p < 0.001
Location:			ns.
right side	39 (51%)	12 (44%)	
left side	38 (49%)	15 (56%)	
Hormonal diagnosis:			ns.
pheochromocytoma	16 (21%)	5 (18%)	
Cushing's disease	7 (9%)	4 (15%)	
Conn's disease	10 (13%)	1 (4%)	
non-functioning tumour	44 (57%)	17 (63%)	
Pathological diagnosis:			p < 0.05
pheochromocytoma	16 (21%)	5 (18%)	
adenoma	47 (61%)	15 (56%)	
other – benign	10 (14%)	3 (11%)	
adrenocortical carcinoma	1 (1%)	1 (4%)	
adenocarcinoma	1 (1%)	2 (7%)	
renal cell carcinoma	1 (1%)	1 (4%)	
neuroendocrine carcinoma	1 (1%)	0 (0%)	

PRA – posterior retroperitoneal approach; LTA – lateral transperitoneal approach; ns. – not significant.

nal gland (Table 1). In PRA, the excised tumor size was 1–8 cm (avg. 4.6 cm), while in LTA the size was 2–10 cm (avg. 6.1 cm) (Table 1). The mean total time of the PRA procedure was 91.8 min and that of the LTA procedure was 153.1 min. Thanks to the experience gained during the subsequent procedures, the mean time of the last 20 PRA interventions was reduced to 68.8 min. Postoperative hospitalization period was 1–5 days (avg. 2.03) for PRA and 2–5 days (avg. 2.67) for LTA. The data is presented in Table 2. Adenoma was the most prevalent postoperative diagnosis. Metastasis to adrenal glands was identified in 6 cases and adrenocortical carcinoma was identified in 2 cases.

In one case, LTA had to be converted into a classical intervention due to bleeding from the liver displaced by a large (10 cm in diameter) adrenal tumor diagnosed postoperatively as adrenocortical carcinoma. Another patient required conversion from PRA to LTA for an apparent occlusion of the intubation tube. One female patient with pheochromocytoma developed pulmonary edema during the LTA procedure. Five patients (3–4% of the PRA group and 2–8% of the LTA group)

reported pain irradiating to the lower abdomen and lasting more than 1 week. Four patients required blood transfusions (2 per group).

## Discussion

Patients were qualified for either PRA or LTA based on the results of diagnostic imaging (ultrasound scanning and computed tomography). Patients with tumors smaller than 7 cm in diameter were qualified for PRA. Patients with tumors larger than 7 cm, or those after nephrectomy or kidney agenesis, were qualified for LTA. One patient with an 8 cm tumor was treated with PRA due to several previous laparotomy procedures and a risk of adhesions.

Thanks to the experience gained during the subsequent procedures, the duration of the video-scopic PRA procedure decreased from ~180 to ~60 min. According to Walz et al., the mean operative time reported for over 500 PRA analyzed procedures was reduced to 40 min [16]. Thus, the duration of the procedure was reduced to that of cholecystectomy or laparoscopic hernia repair.

**Table. 2.** Operative outcomes (n = 104)

	PRA (n = 77)	LTA (n = 27)	p-value
Mean operative time (min) (last 20 operations)	91.8 ± 30.8 68.8 ± 21.7	153.1 ± 50.4	p < 0.001
Blood loss (mL)	51.1 ± 59.7	142.1 ± 127.6	p < 0.001
First oral intake (days)	1.05 ± 0.23	1.46 ± 0.72	p < 0.05
Postoperative hospital stay (days)	2.03 ± 0.6	2.67 ± 1.01	p < 0.01
Conversions	1 <sup>a</sup>	1 <sup>b</sup>	
Complications (acc. to Dindo):	8 (10%)	6 (22%)	ns.
I	4 <sup>c</sup> (5%)	2 <sup>d</sup> (8%)	
II	3 <sup>e</sup> (4%)	3 <sup>f</sup> (11%)	
III	1 <sup>g</sup> (1%)	0	
IV	0	1 <sup>h</sup> (4%)	
V	0	0	

PRA – posterior retroperitoneal adrenalectomy; LTA – lateral transperitoneal adrenalectomy;

<sup>a</sup> – conversion from PRA to LTA due to anesthetist's request – compression of intubation tube;

<sup>b</sup> – conversion from LTA to open adrenalectomy after unsuccessful attempt of creating pneumoperitoneum according to Hasson's technique – due to bleeding from the liver displaced by a large adrenal tumor and extensively adherent to the anterior abdominal wall;

<sup>c</sup> – three patients with pain radiating to hypogastric area lasting > 7 days, one patient requiring physiotherapy for atelectasis;

<sup>d</sup> – two patients with pain radiating to hypogastric area lasting > 7 days;

<sup>e</sup> – two patients obtained blood transfusions (1 or 2 units of red packed cells); one developed pneumonia in postoperative period;

<sup>f</sup> – three patients obtained blood transfusions (2 units of red packed cells each);

<sup>g</sup> – one negative revideoscopy was performed on day 2 after PRA due to fever of unclear origin;

<sup>h</sup> – one patient with pheochromocytoma treated for 2 days in ICU due to pulmonary oedema.

The resectability rate of phaeochromocytoma using minimally invasive methods in our study was 91%. In order to decrease the risk of intraoperative pressure increase during phaeochromocytoma resection, we attempted to avoid tumor mobilization before sealing the adrenal vessels. An increase in the arterial pressure exceeding 170 mm Hg was observed intraoperatively in 18% of the patients from the PRA group and 21% of the patients from the LTA group. In a similar report by Dickson et al., intraoperative arterial pressure increased in 17% of the patients subjected to PRA [20].

The change in the CO<sub>2</sub> insufflation pressure from 12–15 mm Hg (standard value) to 20–28 mm Hg was a breakthrough in RPA [16]. It helped to enlarge the operative field and obtain improved haemostasis thanks to vessel compression. Opponents of the method indicate gas embolism and the release of catecholamines as possible risks of the increase in the CO<sub>2</sub> pressure [21]. However, this has not been confirmed in practice [16, 22].

The CO<sub>2</sub> insufflation pressure reported in this study was 20–28 mm Hg in the PRA interventions and 12–15 mm Hg in the LTA interventions. Increasing the value led to a higher end-expiratory CO<sub>2</sub> pressure. However, this did not result in an

increase in the intraoperative blood pressure or postoperative breathing disturbances.

The lateral transperitoneal approach appears as the preferred method of laparoscopic adrenalectomy [14, 17, 24]. It is due to the broader knowledge of the anatomy of the peritoneal cavity, skills gained in other laparoscopic procedures, as well as a larger operative field. However, according to numerous reports, PRA is easier to perform and is associated with less pain in the postoperative period [16, 22, 25]. The above observations are confirmed by our median operative time for PRA, 91.8 ± 30.8 min and its downward tendency.

The use of laparoscopic interventions in the treatment of malignant tumors remains controversial [26]. Patients diagnosed with adrenocortical carcinoma were excluded from laparoscopic adrenalectomy in this study. Despite the radical inclusion criteria, histological analyses of the removed tumors revealed 6 cases of metastasis and 2 cases of adrenocortical carcinoma. Follow-up examinations performed up to 6 months after the surgery did not reveal any evidence of recurrence.

The study demonstrated that laparoscopic adrenalectomy is an efficient and safe technique performed using either the PRA or LTA approaches. Despite the higher mean age of the study population



in the PRA group, differences in BMI, ASA scores and tumor location were statistically insignificant. Tumor size and the number of hormonally active tumors were greater in the LTA group. Still, we recorded statistically significant differences in the operative time, amount of blood lost intraoperatively, the time it took for the patient to return to oral feeding and hospitalization time. The differences indicated the advantage of PRA.

In our opinion, the choice of the approach should be made based primarily on surgical

experience, patient characteristics, as well as the tumor size and location. PRA is our recommended approach to the resection of small and medium (< 7 cm) adrenal tumors. However, we would recommend LTA in patients without ipsilateral kidney, or with tumors located in high or atypical positions. In order to better compare the two minimally invasive approaches, we are now starting a controlled prospective trial including only tumors amenable to both the LTA and PRA techniques.

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