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# Laparoscopic Left Adrenalectomy with Submesocolic and Retropancreatic Approach

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## Abstract

**Introduction:** The safety and efficacy of laparoscopic transperitoneal lateral adrenalectomy and retroperitoneoscopic adrenalectomy have been reported. The aim is to report the authors' experience in laparoscopic left adrenalectomy with an alternative transperitoneal submesocolic and retropancreatic approach with patient supine.

**Research methods:** The authors have performed laparoscopic transperitoneal submesocolic, retropancreatic adrenalectomy for both benign and malignant, functioning lesions >4cm in diameter or with smaller lesions but having an imaging pattern suspicious of malignancy or of sub-clinically secreting tumors. After opening the posterior peritoneum at the root of the transverse mesocolon and Gerota's fascia, the junction of the inferior adrenal vein with the left renal vein is identified. The adrenal vein is then prepared and divided, followed by mobilization and removal of the left adrenal gland.

**Conclusion:** Early ligation of the adrenal vein is the most relevant technical feature of this procedure to avoid the release of catecholamines, hormones or neoplastic cells which could occur during manipulation of the gland prior to ligation of the main adrenal vein. Moreover, this approach makes it possible to perform associated procedures, including a bilateral adrenalectomy, without the need to reposition the patient on the operative table, but simply by positioning additional trocars.

**Keywords:** adrenal tumors, laparoscopic adrenalectomy, pheochromocytoma, transperitoneal anterior approach, submesocolic retropancreatic approach

## 1. Introduction

The surgical approach to the adrenal gland has raised debate among surgeons due to its retroperitoneal location and for the complexity in the management of secreting tumors, particularly in case of pheochromocytoma (PHE) [1–3]. Traditionally, open adrenalectomy is made difficult due to its deep anatomical location, and it is associated with up to 39% morbidity rate and prolonged hospital stay [1–3]. In 1992, Gagner described the first laparoscopic adrenalectomy (LA) by a transperitoneal approach with the patient in the lateral decubitus position [4, 5]. This initial experience has been followed by others using the same approach or, alternatively, the retroperitoneal approach with the patient in the prone or in the lateral decubitus position [6, 7] and the transperitoneal approach with the patient supine [8]. Several reports have confirmed the safety and efficacy of these techniques, and minimally, invasive adrenalectomy is presently considered the treatment of choice for a variety of benign lesions, including lesions of the medulla [9, 10].

The aim of the present chapter is to report the authors' experience with left laparoscopic adrenalectomy (LA) using an original transperitoneal submesocolic and retropancreatic approach with patient supine, to describe the patient's preparation for surgery as well as the operative details of this procedure.

## 2. Methods

In order to establish the diagnosis in case of adrenal secreting lesions, all patients undergo complete hormonal evaluation as previously reported [11]. Diurnal serum cortisol, dehydroepiandrosterone (DHEAS), plasma adrenocorticotrophic hormone (ACTH), testosterone, androstenedione, urinary free cortisol (UFC), 17-hydroxyprogesterone (17-OHP), renin activity, aldosterone and urinary catecholamine levels are measured, together with overnight 1-mg dexamethasone suppression test (DST) [11]. Aldosterone-producing adenoma, pheochromocytoma and Cushing's syndrome are diagnosed on the basis of high plasma aldosterone, plasma renin activity (PRA) ratio ( $>40$ ) and unsuppressed aldosterone after sodium load, elevated urinary metanephrines, elevated UFC, abnormal serum cortisol, inadequate cortisol suppression after 1-mg dexamethasone and low and/or suppressed plasma ACTH [11]. When no specific signs and/or symptoms of autonomous hormone secretion are present, or abnormal hypothalamus-pituitary-adrenal axis tests and radiological imaging suggesting the presence of an adrenocortical lesion, a diagnosis of nonfunctioning adenoma is made [11].

All patients are studied with computed tomography (CT) scan and magnetic resonance imaging (MRI). An attenuation value of 10 or less Hounsfield units (HU) on unenhanced CT scan is suggestive for the presence of a benign adrenocortical adenoma [12]. Relative contrast washout of  $>40\%$  and an absolute contrast washout of  $>60\%$  are suggestive for an adenoma, with 92% specificity and 98% sensitivity rates, respectively [13, 14]. In all sequences during MRI,

adrenocortical adenomas are homogeneous, with mild gadolinium enhancement [12], with low or equal signal intensity as the liver on T2-weighted images may appear on lower signal intensity than the rest of the adrenal gland [12]. Chemical shift imaging can be done during MRI to identify fat within the lesion as decreased signal intensity relative to normal tissue [12]. For carcinomas, the attenuation on unenhanced studies is higher than 10HU on CT scan [15]. On contrast-enhanced studies, carcinomas enhance greedily due to their vascularity, and the enhancement pattern may be homogeneous, unless there is central necrosis [15, 16]. The relative percentage washout of carcinomas is <40% [17]. At MRI, adrenal carcinomas are noted for heterogeneity on T1-weighted images, with intermediate to high signal intensity [18]. Heterogeneity is also noted on T2-weighted images due to hemorrhage and/or necrosis [18]. Based on these criteria, adrenal lesions larger than 4 cm in diameter or with smaller but having an imaging pattern suspicious of malignancy or of sub-clinically secreting tumors are an indication for laparoscopic adrenalectomy.

## 2.1. Patient's preoperative preparation

### 2.1.1. Pheochromocytoma

Alpha-blockers (doxazosin 20mg/day), starting at least 15 days before surgery, are administered. If patients reported episodes of tachycardia, beta-blockers are also administered (atenolol 100–200mg/day orally). On the day before surgery, treatment with alpha-blockers is discontinued, and intravenous (iv) normal saline 2000cc is administered to expand the plasma volume [19].

### 2.1.2. Conn's syndrome

Iv hydrocortisone 100mg is administered at induction of anesthesia. Iv spironolactone is used for potassium control [20].

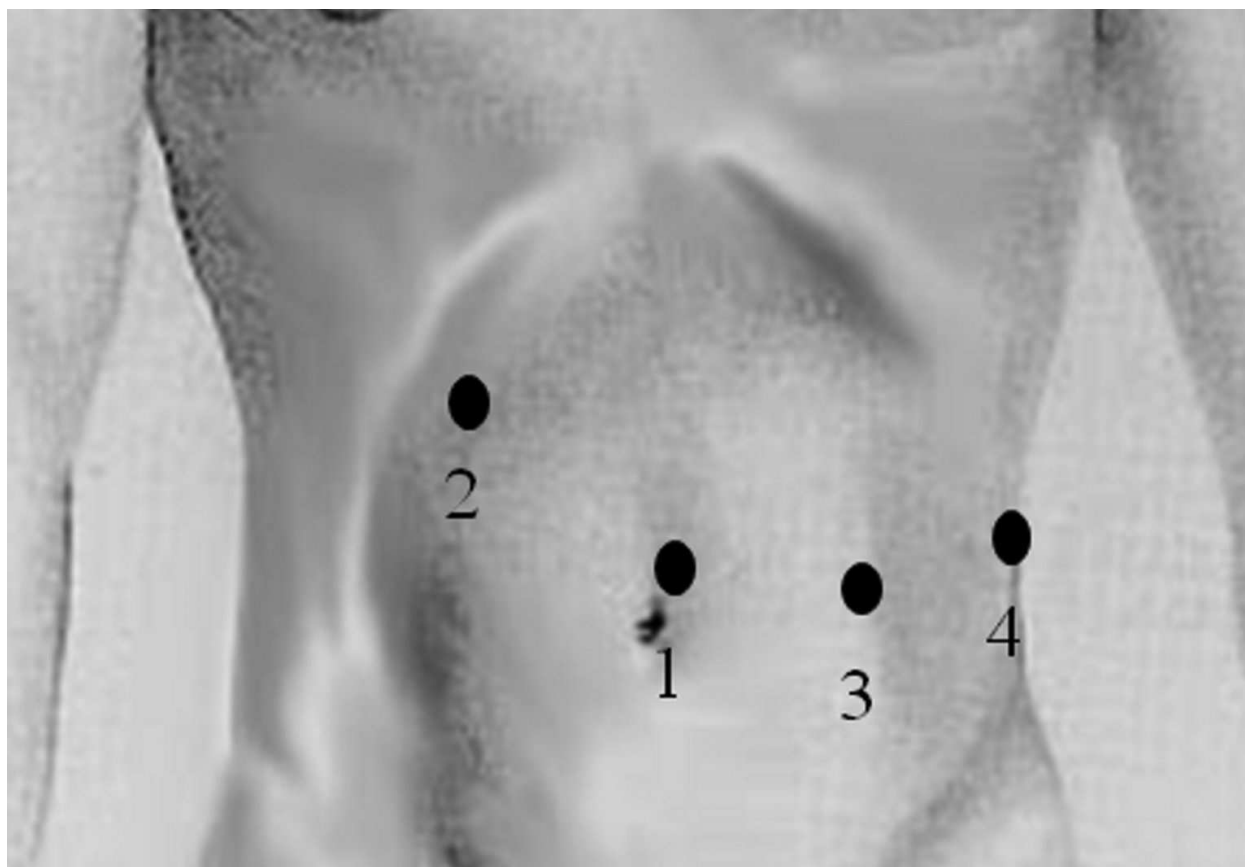
### 2.1.3. Cushing's syndrome

Iv hydrocortisone 100mg is administered at induction of anesthesia and then iv hydrocortisone 50mg every 8h [20].

## 2.2. Surgical technique

### 2.2.1. Left adrenalectomy: transperitoneal anterior submesocolic and retropancreatic approach

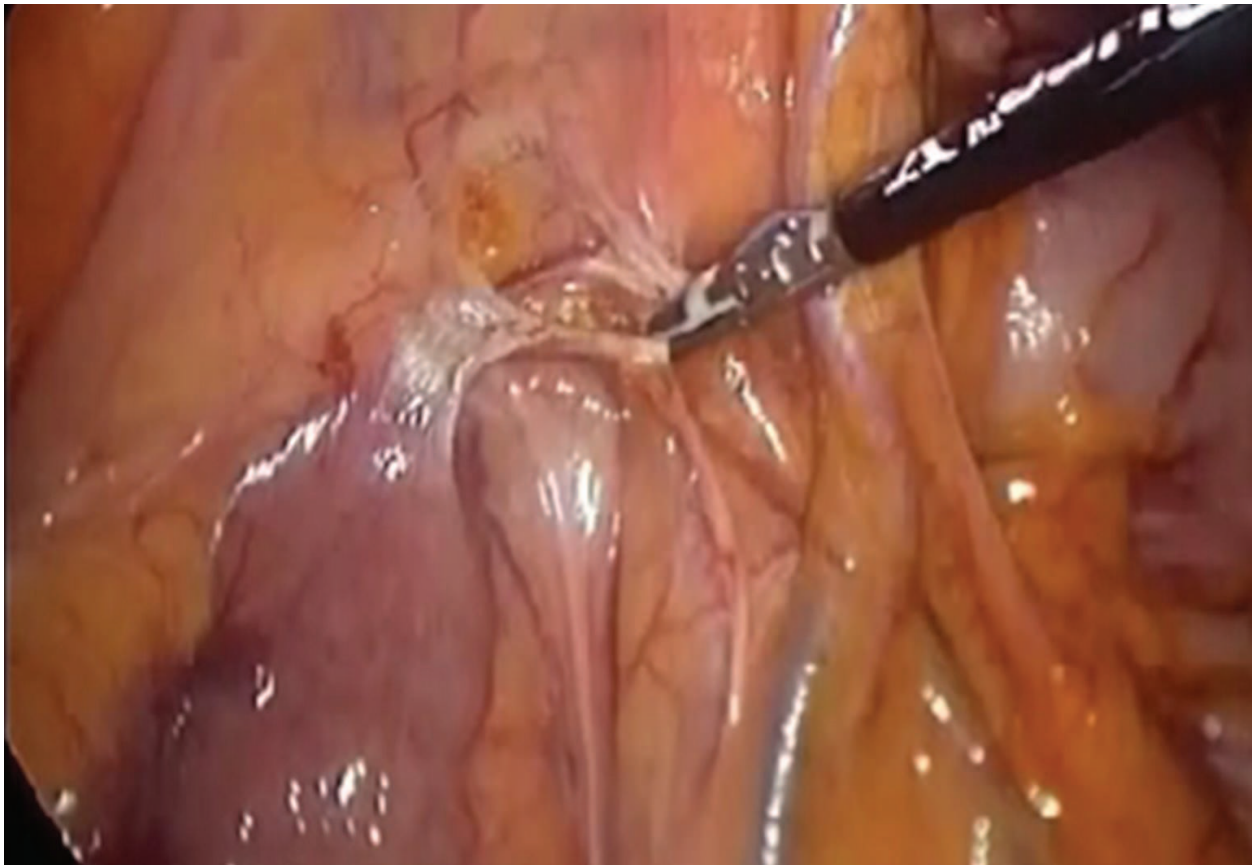
Surgery is performed under general anesthesia. An orogastric tube and urinary catheter are positioned. Intraoperative patients' monitoring includes intra-arterial radial artery catheter for continuous blood pressure measurement and a central venous catheter (subclavian or internal jugular access) for rapid infusion of liquids. Pneumoperitoneum is usually established with a Veress needle at the umbilicus or with an open technique and Hasson cannula, in case of the presence of abdominal scars from previous surgery. Pneumoperitoneum is set at a pressure of 12–13mmHg, with carbon dioxide flow adjusted at 30lt/min. Four trocars and a 30°/45°



**Figure 1.** Trocars' position during left transperitoneal submesocolic and retropancreatic adrenalectomy. The surgeon and first assistant stand on the left of the patient, while the second assistant stands on the right.

forward oblique optic are used. This approach is performed with the patient supine, in slight anti-Trendelenburg position and with the operating table turned 30° with the side opposite the lesion down, to facilitate exposure of the surgical field. The surgeon stands on the side which is ipsilateral to the lesion.

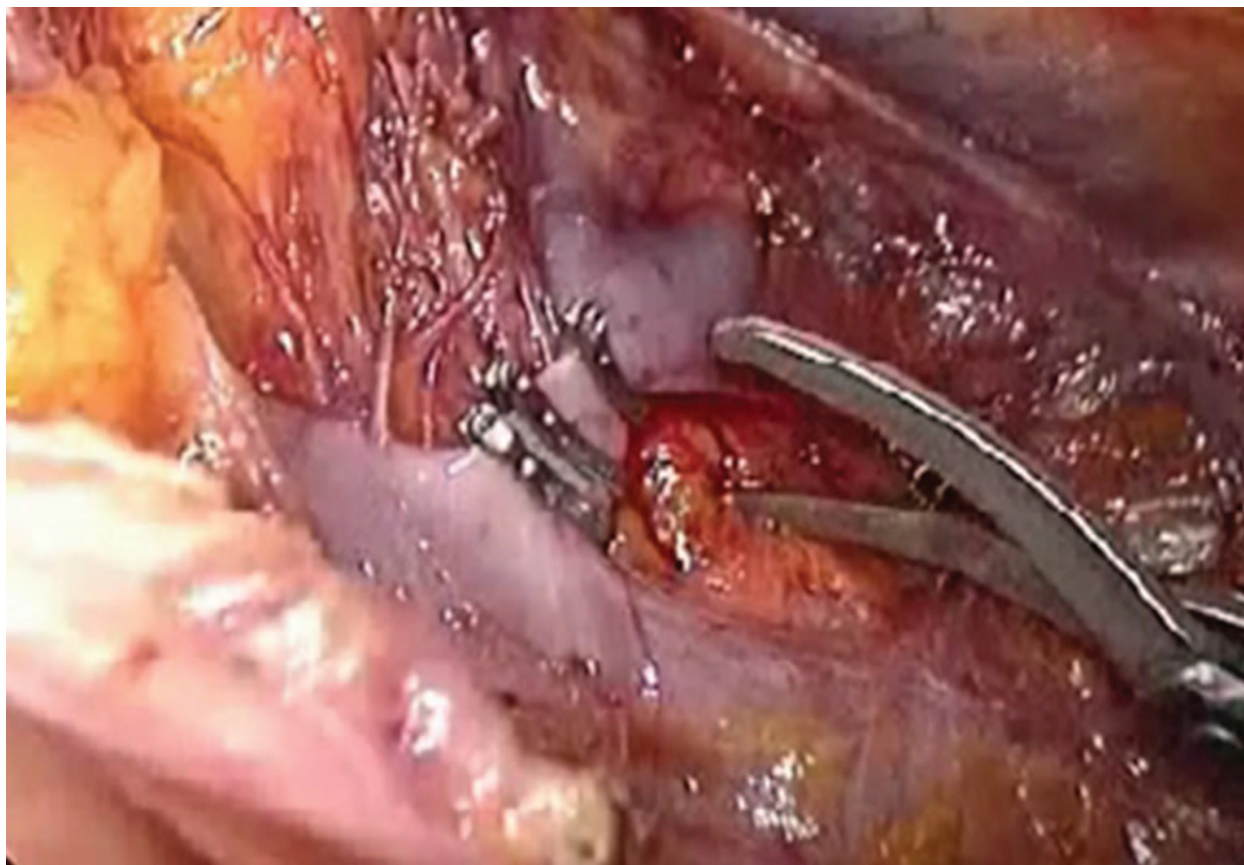
After induction of pneumoperitoneum, the first 12-mm optical trocar (n. 1) is inserted on the left of the midline above the umbilicus (**Figure 1**). A second 12-mm trocar (n. 2) is inserted under vision on the right midclavicular line below the right costal arch. The third and fourth 12-mm trocars are placed one on the left midclavicular line along with the transverse umbilical line (n. 3) and other on the left anterior axillary line (n. 4), respectively (**Figure 1**). The 10-mm laparoscope is introduced from trocar (n. 3), while trocars 1 and 4 are the operating ones. With atraumatic forceps introduced from trocar (n. 2), the transverse mesocolon is raised by the assistant. This maneuver discloses the first jejunal loop at the ligament of Treitz, and it shows the arch of the inferior mesenteric vein. The operative table is tilted with the left side of the patient up, which allows the surgeon to displace the first jejunal loops on the patient's right side (**Figure 2**). The posterior peritoneum is opened at the insertion of the transverse mesocolon and posteriorly to the lower edge of the pancreas, between the first jejunal loop and the arch of the inferior mesenteric vein or immediately lateral to this vessel, according to



**Figure 2.** After raising the transverse mesocolon and displacing the first jejunal loop on the patient's right side, the posterior peritoneum is divided close to the arch of the inferior mesenteric vein.

its distance from the jejunum. Toldt's fascia appears at this point as a whitish film. The dissection then proceeds posteriorly along the retro-pancreatic space, after raising the body of the pancreas with an atraumatic instrument held by the surgeon's left hand. The splenic vein is visible at this point running along the posterior aspect of the pancreas. Gerota's fascia is now opened to visualize the left renal vein, which is followed medially, until the left inferior adrenal vein is identified. This is cautiously prepared and divided between clips (AcuClip, Tyco/Healtcare, Norwalk, Connecticut, USA, **Figure 3**). No manipulation of the left adrenal gland has yet occurred prior to division of the adrenal vein because the gland is located cranially to this vessel. Only at this point, the gland is mobilized using a radiofrequency (LigaSure™ tissue fusion, Covidien, Mansfield, Massachusetts, USA) or ultrasonic (Ultracision, Harmonic Scalpel, Ethicon Endo Surgery, Cincinnati, Ohio, USA) device, and the specimen is removed from the abdominal cavity inside a specimen retrieval bag after slightly enlarging the periumbilical trocar incision [19].

Near-infrared indocyanine green (NIR-ICG) fluorescence may be employed during surgery and may be useful to aid in vascular structures and adrenal gland identification amidst retroperitoneal and perirenal fat, particularly in obese patients, to improve the safety of laparoscopic adrenalectomy.



**Figure 3.** The left adrenal vein is divided between clips. Confluence of the diaphragmatic vein to the left adrenal vein is visible.

### 3. Discussion

Surgery is the standard treatment of Conn's syndrome, Cushing's disease, pheochromocytoma, primary adrenal cancer and adrenal metastases. After the introduction of minimally invasive adrenalectomy, this has now become the treatment of choice [8, 21–26]. Minimally, invasive adrenalectomy is mostly performed either with a transperitoneal lateral approach or with a retroperitoneal approach [4]. The laparoscopic transperitoneal anterior approach has been proposed only by few centers [8, 11, 19, 23, 24, 26].

The transperitoneal lateral approach, originally described by Gagner et al. [4], is performed with the patient in the lateral decubitus position. It gives excellent exposure of the operative field with a wide working space, and it facilitates orientation by providing readily identifiable anatomical landmarks [27]. Its proponents report several advantages, such as a rapid and direct access to the gland without the need to retract any organ and with minimal patient trauma [28], a clear operative field due to gravity that keeps blood and bowel away from it and the need for less surgical dissection on the left side, as compared to the anterior approach [26]. By the authors' opinion, the main disadvantage of the lateral approach is that it does not provide early ligation of the adrenal vein prior to gland manipulation, which the authors

believe to be important so as to avoid pressure instability in case of secreting adenomas, and particularly of pheochromocytoma, and which would also be oncologically correct [11, 19, 29].

Retroperitoneal adrenalectomy (RA) has also been reported to be safe and effective [21, 30, 31]. According to its proponents, it is preferred to reduce the risks and possible complications of a transperitoneal access, such as incisional hernias and paralytic ileus from bowel manipulation [4, 7]. It has been reported to require less analgesics due to lower postoperative pain [27] and to be associated with earlier recovery of bowel function, possibly leading to shorter hospital stay [27]. However, minimal postoperative pain, early liquid diet and a short hospital stay have been reported also after a laparoscopic approach [5, 6, 26, 27]. RA is preferred in patients with abdominal adhesions from previous surgery and in obese patients [32]. Moreover, several authors reported a shorter operative time [28]. According to Walz et al. [33], a 7 cm hormonally active tumor or a 4–7 cm nonfunctioning tumor may be indications for a retroperitoneal approach. By the opinion of these authors, severe obesity, simultaneous abdominal pathology, patients with evident signs of malignancy or a tumor exceeding 8 cm are contraindications for the retroperitoneal approach [33]. In our opinion, the patient's position during RA is unfavorable for rapid conversion to open surgery in case of major bleeding and may itself impair or worsen the hemodynamic conditions of the patient [8].

Moreover, both lateral LA and RA do not allow to perform associated surgical procedures [11, 19, 34]. In lateral LA, exploration of the contralateral gland is not possible without repositioning the patient [11, 19, 34], which increases the operative time.

To reduce the risk of catecholamines, hormones or neoplastic cells spread from the adrenal gland, the authors introduced the laparoscopic transperitoneal submesocolic and retropancreatic approach with the patient supine. This approach was originally described by Pierre Delbet in 1912 [35]. Its main advantages are the limited extent of the dissection and early identification, ligation and division of the left adrenal vein which is obtained prior to any gland manipulation. This aspect is particularly important in case of secreting lesions. In fact, the authors consider early clipping of the main adrenal vein to be of utmost importance, together with avoiding any manipulation of the gland prior to adrenal vein ligation [11, 19, 24, 26, 36].

With respect to the transperitoneal anterior and lateral approaches, it does not require mobilization of the left colonic flexure or of the spleno-pancreatic complex to gain access to the adrenal gland, with reduction of the operative time and of potential operative risks. However, it does require experience in advanced laparoscopic surgery because the operation is conducted in a restricted working space adjacent to major venous vessels, such as the left renal and splenic veins, and the aorta [11, 19, 37].

In case of LA or RA for pheochromocytoma, because of the complexity of the disease, the operation should be performed only in centers with a well established, multidisciplinary experience in the diagnosis and treatment of adrenal gland pathology. In fact, surgery for pheochromocytoma is at risk of hypotensive or hypertensive crisis, or both, due to an excess in catecholamine release, which cannot be completely prevented even by adequate preoperative preparation with  $\alpha$ -blockers [10]. The aim of medical treatment prior to surgery is not the



reduction of hormonal secretion but the prevention of the peripheral effects of catecholamines secreted by the tumor, so that the patient may undergo surgery under the best cardiovascular conditions [38]. Advances in intraoperative monitoring and the introduction of preoperative  $\alpha$ 1-receptors' blockade have radically reduced the mortality rate [39]. A significant increase in the rates of plasma norepinephrine release related to mobilization of the adrenal gland has been reported during LA with a lateral approach [39]. One study also reported that severe hypertension was triggered by direct manipulation of the adrenal gland [10]. Instead, no significant intraoperative change in blood pressure was observed following this surgical strategy in case of pheochromocytoma [19]. Based on the authors' data, the anterior laparoscopic submesocolic and retropancreatic approach for treatment of secreting adrenal lesions is safe [11, 19, 24].

Authors	N	Approach	Mean age (years)	Mean oper. time (min.)	Conversion (%)	Morbidity (%)	H.S. (days)
Hazzan [2]	24	Lateral	45.4	188	7	16	4
Vargas [3]	20	Lateral	47	193	10	10	3.1
Gagner [5]	100	Lateral	46	130	3	12	2.5
Bonjer [6]	79	RP	50	114	6.3	10.1	2
Salomon [7]	21	RP	46	116	0	19	3.4
Lang [9]	56	RP	36.2	52	1.8	1.7	5.2
Janetschek [10]	19	Lateral	49.7	150	0	16	7
Mohammadi-Fallah [27]	11	Lateral	43	129	0	9.1	3.6
	12	RP	42	128	8.3	8.3	3.1
Dickson [30]	23	Lateral	42	145	4.3	8.7	3.1
	23	RP	47	100	13	13	1.9
Fernández-Cruz [31]	16	Lateral	36	89	12.5	12.5	3
	14	RP	47	105	14.2	0	2.75
Walz [33]	560	RP	49.2	67	1.7	11.8	–
Cabalag [44]	13	Lateral	47	105	0	30.7	2
	10	RP	61	90	0	10	1
Paganini [11]	19	LASA	54	92	0	0	4.4
Paganini [19]	37	LASA	54	82.7	0	0	3.85
Matsuda [29]	75	Anterior	–	221	0	3.9	10.2
Linos [45]	18	Anterior	48.7	116	5.5	0	2.3

N, number of patients; H.S, hospital stay; RP, retroperitoneal; LASA, left anterior submesocolic approach.

**Table 1.** Patient series reported in the literature.

Some authors [40, 41] consider tumors larger than 6 cm to be a contraindication for a minimally invasive approach, due to the risk of malignancy. In the authors' experience, the size of the largest lesion up to 10 cm in diameter did not affect the feasibility and the outcome of the procedure or the operative time [11, 19, 24]. This observation has been confirmed by Parnaby et al. [42], whose results are in agreement with the authors' experience [11, 19, 24].

Moreover, the supine position of the patient allows one to perform associated diagnostic [43] or operative procedures, such as contralateral adrenalectomy, without the need to reposition the patient on the operative table. In the authors' experience, the submesocolic approach was associated with a significant reduction in the operative time, as compared to the laparoscopic traditional anterior approach, which compares favorably also with the operative time of the lateral and retroperitoneal approaches reported in the literature (**Table 1**) [2, 3, 5–7, 9–11, 19, 27, 29–31, 33, 44, 45].

Independently from the approach that is followed, the recent introduction of a dedicated laparoscopic instrumentation to detect near-infrared fluorescence with indocyanine green (NIR-ICG) improves visualization of the inferior adrenal vein and of the adrenal gland with respect to the surrounding fat, making their identification easier [46, 47]. In the authors' opinion, this instrumentation might improve the safety of the procedure, as well as the oncological outcome in case of adrenal cancer or metastases.

LA with transperitoneal submesocolic and retropancreatic approach has proven to be safe and effective [11, 19, 24], and its results are in line with those reported in the most recent literature [48] after RA and lateral LA. Early ligation of the adrenal vein is the most important technical feature of this technique in every type of lesion. For more objective results, a multicenter randomized clinical trial comparing the submesocolic approach with lateral LA and RA for left adrenalectomy would be required.

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