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Transperitoneal Approach for Laparoscopic Adrenalectomy

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Abstract: The most effective surgical method for removing adrenal gland cancers is laparoscopic adrenalectomy (LA). Twenty years after its initial description in the literature, the method continues to provide better perioperative and operational results than the open adrenal gland approach. In addition to facilitating quicker patient release and resumption to normal activities, these have enhanced cosmesis, decreased postoperative discomfort, and decreased morbidity. Research has shown that LA is a safe and effective treatment option for a variety of adrenal disorders, including primary and secondary adrenal cancers, pheochromocytoma, Cushing's syndrome, Conn's syndrome, and both functional and non-functional adrenal incidentalomas. We detail the history and current state of the adrenal gland laparoscopic transperitoneal technique.

Keywords: *Transperitoneal Approach, Laparoscopic Adrenalectomy*

Introduction.

The procedure of laparoscopic adrenalectomy (LA) has been the gold standard for removing minor benign adrenal lesions in most countries since its introduction in 1992 [1]. While Cushing's syndrome and pheochromocytoma were the original indications for LA in Gagner's study, the list of indications has now expanded to include adrenal metastases and the majority of benign adrenal lesions. Nevertheless, there is ongoing discussion regarding the optimal size limitations and LA's applicability to malignant adrenal tumors. Some of the advantages of LA are comparable to those of minimum access surgery in general, including shorter recovery times and less blood loss after surgery, fewer complications, and improved cosmetic outcomes [2]. In this review, we will try to compile all the information about transperitoneal LA that has been published in the last 20 years.

Indications for LA

It is predicted that 5% of patients undergoing computed tomographic (CT) scans of the abdomen and chest will have an adrenal tumor [3]. The detection of adrenal tumors is expanding at a quick pace due to the exceptional increase in the number of cross-sectional imaging investigations conducted. According to the Nationwide Inpatient Sample (NIS) database, the number of adrenalectomies performed annually in the US rose from 3,241 in 1998 to 5,019 in 2006 [2].

Sequential imaging may be used to detect benign, non-functioning lesions under 3 cm in size, while laparoscopic removal may be explored for bigger or functional lesions. Before considering surgery on the adrenal gland, a proper endocrine workup must be done. The type of adrenal cortical or medullary lesion can be better understood with the use of metabolic parameters measured in serum and urine in conjunction with radiological and nuclear medical imaging findings. Equally crucial is the ability to pinpoint the lateral location of functional deficits.

Presently, LA is used to treat non-functioning incidentalomas, functioning adrenal cortex lesions like aldosteronomas, glucocorticoid and sex-steroid producing adenomas, bilateral functional hyperplasia, pheochromocytoma, Cushing's disease, and other, less common, conditions like adrenal cysts and myelolipomas.

There has been a dramatic uptick in the number of studies reporting positive results using laparoscopic adrenalectomy in the treatment of Conn's syndrome [4–11]. Research has shown that adrenalectomy can be successfully performed laparoscopically with minimal or no conversion required. Up to 90% of patients have shown an overall improvement in clinical and biochemical indicators, and our unit has shown a 30% cure rate with LA [4].

There has been ample evidence of the efficacy of LA in treating Cushing's syndrome and related diseases since the late 1990s [12]. In a study comparing LA to open adrenalectomy (OA), Acosta and colleagues found no significant difference in cure rate or morbidity.

Preoperative preparation is crucial for pheochromocytoma patients in order to prevent a hypertensive crisis during surgery. Orthostatic hypotension is achieved by gradually increasing the dose of alpha-adrenergic blockage. The specific regimen of metyrosine and phenoxybenzamine, which typically lasts for around two weeks prior to surgery, differs among centers and is determined by the preferences of the surgeons and doctors. In order to prevent a spike of catecholamines during surgery, it is crucial to limit tumor manipulation and leakage as much as possible. Because a surge of catecholamines and an increase in systolic blood pressure occur even during induction of pneumoperitoneum (as demonstrated by Joris et al.), a skilled anesthesiologist is crucial. The process itself, when the gland is touched, causes the primary spike, but [13]. We have highlighted the benefits of LA for pheochromocytoma [14], and numerous big studies [5, 15, 16] in the previous decade have done the same.

Despite much discussion, no universally accepted threshold for size has been established. Thanks to advancements in technology, the scope of prescription for LA has been effectively broadened to include tumors larger than 6 cm, in addition to minor benign lesions (<6 cm). Even for bigger adrenal neoplasms without preoperative or intraoperative signs of cancer, our institution has previously reported that a LA is safe [17].

Contraindications to LA

Extreme obesity and a history of abdominal surgeries with known adhesions are relative contraindications to LA. Initial laparoscopic evaluation and division of adhesions may still offer a suitable and safe working environment, therefore prior abdominal surgeries should not be considered an automatic contraindication [18]. Morris and colleagues demonstrated that previous surgery does not hinder or contraindicate LA, and patients are offered the same benefits both intraoperatively and postoperatively [19], contributing to the rising prevalence of laparoscopic abdominal procedures.

Extreme cardiac pathology (severe heart failure, severe aortic stenosis, and mitral valve insufficiency), uncontrolled hypertension, severe sepsis, and severe non-correctable coagulopathies are among the general contraindications of LA [20].

It is absolutely forbidden to use LA on lesions that have shown signs of local invasion, as this would necessitate en bloc excision in order to achieve satisfactory oncological results. Although there is still some disagreement, LA has shown equivalent oncological results in some units when used to remove primary or secondary malignant adrenal neoplasms, therefore it is no longer seen as an absolute contraindication [21].

Operative Technique: Lateral Transperitoneal Approach

A substantial incision using the anterior approach is necessary to access the adrenals, which are relatively tiny organs located high in the retroperitoneum [22]. The trauma induced by the surgical access is far greater than the trauma caused by the procedure itself. Since the introduction of LA, this drawback of OA has been completely eradicated.

Access: Patient Position and Trochar Placement

Important in LA is the patient's location. When the patient is properly positioned, the surgeon has better ergonomics and easier access to the adrenal gland; when the patient is improperly positioned, the surgeon has less room to work with, has trouble placing the trochar, and is frustrated. First, position the patient so that their costal margin and iliac crest are as far apart as possible in the lateral decubitus position; second, ensure that they are securely supported so that they can move around on the table and not lose their position during the operation; and third, protect all pressure points adequately.

Once general anesthesia has been administered, the patient is positioned in the lateral decubitus position, with the adrenal lesion's exposed side facing upward. Put a beanbag under the patient before induction if you're going to use one. Side supports can also be used to keep the patient in the lateral decubitus posture. The patient should be positioned with their anterior superior iliac spine above the table's break point and the table flexed in an inverted "V" posture to maximize distraction of the area between the costal margin and iliac crest before they are secured in that position. This perspective differs from person to person. After achieving the desired posture, the patient is fastened in place by sucking on the beanbag or tightening the side supports, making sure that they do not overlap with the operating field.

To alleviate pressure, you can use a liter bag of fluid or a padded axillary roll. Padding the lower leg's lateral malleolus and lateral peroneal nerve is a must. To alleviate pressure on the upper leg, a cushion is wedged between the two legs. To ensure the patient is firmly attached to the table, more tape might be used, particularly to stop the upper body and legs from rotating. Rest a cushion or arm brace on the shoulder of the highest arm so that it is at least 90 degrees from the torso.

The initial port is positioned at the anterior axillary line, two to four fingerbreadths below the costal margin. Under direct eyesight, the peritoneal cavity is entered and a cut down is performed. To help with sealing, a balloon port is utilized. Working ports can be introduced under direct vision on either side of the camera port after pneumoperitoneum at 12-15 mmH2O with CO2. To ensure appropriate triangulation, provide at least 5 cm of space between ports. If a vascular stapling device needs to be passed through, at least one of these functioning ports should be a 10-mm port. Another option is to use two 5-mm ports and convert them to a 10-mm port as needed. In most cases, a right LA liver retractor will need a fourth 12-mm port.

Right LA

After separating the right triangle ligament, the liver is retracted medially using a fan or paddle retractor through an epigastric port, allowing the right lobe of the liver to be mobilized. When draining the caudate lobe into the inferior vena cava (IVC), it is important to keep the hepatic accessory veins from avulsion [23, 24]. Once the right hepatic lobe has been retracted, the next step is to locate the inferior vena cava, adrenal lesion, and right kidney.

The right adrenal vein is anticipated to meet inside the developed plane that extends from the adrenal gland's medial edge to the inferior vena cava (IVC) lateral edge. All the way down the gland's medial border, all the way back to the psoas muscle, the plane is developed. It is important to exercise caution while dissecting this plane following the division of a right adrenal vein[23,24] because 13% of autopsy series have revealed anatomical changes, such as draining into accessory hepatic veins or duplicate right adrenal veins. Several techniques exist for ligating veins, such as energy-sealing devices, clips, and vascular staplers, which are size dependent [25]. A renal artery auxiliary branching toward the superior pole can be observed as the dissection of this plane moves inferiorly. To prevent renal pole infarction, it should be kept. It is important to prevent accidentally injuring the hilar arteries while dissecting a low-lying limb of the adrenal gland since its inferior limb can extend as far inferiorly as the renal hilum.

Separating the inferior adrenal border from the superior renal pole allows dissection to proceed laterally, and raising the adrenal gland off the psoas muscle allows dissection to continue superiorly. The medial adrenal border has already been established. The dissection is finished by releasing the gland from its lateral and superior attachments. The adrenal gland receives its blood supply from its periphery, hence this stage of the dissection is best performed using an energy sealing device [25].

Left LA

Dissecting the tiny peritoneal attachments from the larger omentum is the first step in defusing the spleen with the left LA. Through dissecting the lienorenal ligament and extending dissection onto the posterior surface of the pancreatic tail and splenic arteries, the plane between the splenic flexure, mesocolon, and kidney is created, and the spleen is mobilized. After dividing the spleen's diaphragmatic attachments superiorly, the stomach's fundus may be seen, and the spleen can be rotated medially without retracting. The left adrenal vein is located after incisions are made in the retroperitoneum along the adrenal gland's medial edge. This vein can be located with the help of the inferior phrenic vein, which branches off to the left adrenal vein and then the left renal vein. Another option is that the adrenal vein can be found by following the left renal vein.

A medial-to-lateral and inferior-to-superior energy-sealing device can be used to dissect the adrenal gland after ligating the adrenal vein, which is attached to the superior renal pole and psoas muscle.

Special Considerations

Although the aforementioned general principles of LA should be followed, there are extra technical guidelines that can be helpful when removing certain types of lesions. To avoid addressing the tumor directly, it is helpful to "dissect the patient away from the tumor" when excising a pheochromocytoma. A spike of catecholamine release into the circulation, leading to hemodynamic lability, may occur if the tumor is subjected to excessive pressure. Never hold the gland; instead, use periadrenal fat, the detached vein, or retroperitoneal fascia as "handles" to delicately retract the tumor if required. A further strategy to reduce catecholamine secretion is the early closure of the adrenal vein.

Following the oncological principle of en bloc resection to include the peri-adrenal fat is crucial when resecting metastatic deposits in the adrenal glands [26•]. In addition to being a good cancer treatment option, an en bloc resection spares the gland the dissection that is often necessary due to inflammatory adhesions caused by cancer. Starting the dissection on the medial side and controlling the adrenal vein early in the procedure is normally preferred, but it might be challenging to do so with large tumors. To access the medial border and ligate the adrenal vein, it may be necessary to mobilize the lateral and inferior margins of the gland in such a scenario. Additional retraction may be necessary with large spleens, which may necessitate a fourth port.

Surgical Outcomes

Complications

Numerous studies have shown that laparoscopic adrenalectomy is the most effective method for removing the adrenal gland during surgery. When comparing the laparoscopic method to the open method for adrenal surgery, several advantages become apparent, including less blood loss, less pain, less ileus, less perioperative morbidity, quicker recovery, and better cosmesis.

Hemorrhage is the most common intraoperative complication. The total rate of problems can reach 40% [27]. Increasing insufflation pressures, simple electrocautery, endoscopic clips and ligatures, and, in extremely rare instances, a switch to an open laparotomy are all options for laparoscopic control of this. During the technique's history, the documented conversion to open surgery ranged from 6.0% in some early investigations [28] to a low of 0.6% in a recent large research by Kulis and colleagues [29].

Organ damage, particularly to the kidney, liver, and spleen, as well as other visceral and solid organ injuries, can occur during surgery [30]. In their 2004 literature analysis, Assalia and Gagner [27] cited a 9.5% rate of intraoperative complications; however, the reliability of this figure was unclear because no universally accepted definition was available.

There is a substantial difference in the death rates linked with LA and OA, even though both are said to have low rates (0.6 vs. 1.3%, p<0.0001) [2•]. It has also been repeatedly shown that LA has a shorter duration of stay (3.2 vs. 5.2 days, p<0.0001) and a lower morbidity rate (4.5 vs. 7.8%, p<0.0001) compared to OA [2, 31, 32].

Outcomes Comparison Between Open and Laparoscopic Adrenalectomy

No randomized controlled trials comparing LA with OA have been conducted to yet. Regardless, Los Angeles has clearly benefited from the trend during the past 20 years. Several meta-analyses comparing open adrenal surgery with LA have looked at the two procedures' efficacy, safety, and results (Table 1). The projected blood loss in an OA is higher than the blood loss in LA, which is still a major problem. Because of this, the OA group also has a higher need for blood transfusions after surgery.

The overall operating time was the only variable in LA that varied across studies. A number of early adopters of the laparoscopic approach have noted that it takes more time during the operation than the open approach. Nevertheless, the focus has moved towards a reduction in operating time due to technological advancements, modernization of laparoscopy, and experts' increased familiarity with the procedure. In a recent case series involving 306 patients, the operating time was reduced to less than 100 minutes by Kulis and colleagues [29].

Table 1 Outcomes comparison between open and laparoscopic adrenalectomy

Series and year	Number of patients	Tumour size (cm)	Operative time (min)	Estimated blood loss (cc)	Length of stay (days)	Morbidity (%)	Time to regular diet (days)	Time to return to normal activity
Strong et al. [21]	31 Lap	NR	175 ± 9	106 (78–134)	2.8 ± 0.4	0	NR	NR
	63 Open	NR	208 ± 13	749 ± 108	8.0 ± 0.5	11	NR	NR
Ramachandran et al. [39]	22 Lap	3.3 ± 0.56	199.7 ± 14.3	NR	3.95 ± 0.32	14	NR	NR
	23 Open	2.4 ± 0.40	143.7 ± 5.9	NR	10.16 ± 0.83	39	NR	NR
Haveran et al. [61]	45 Lap	4.3 (0.5–11)	171 (90–375)	96 (10–500)	2.5 (2–8)	4	1.9 (0–4)	NR
	19 Open	5.5 (1–10)	229 (100–550)	371 (5–1,200)	5.8 (3–12)	47	4.4 (1–7)	NR
Prager et al. [62]	102 Lap	3.8 (3.0–10.0)	NR	NR	NR	9	NR	NR
	48 Open	6.8 (2.0–16.0)	NR	NR	NR	21	NR	NR
Barreca et al. [34]	79 Lap	3.9 (1.5–9.0)	168.6 (60–400)	208 (50–700)	4.2 (2–15)	5	NR	18.8 (7–28) days
	93 Open	3.8 (1.5–9.0)	132.3 (60–305)	269 (50–700)	10 (3–30)	10	NR	29.4 (14–67) days
Hazzan et al. [37]	28 Lap	3.6 (0.5–8)	188	NR	4	16	2	2.2 weeks
	24 Open	2.9 (0.5–7)	139	NR	7.5	39	3.9	5.2 weeks
Imai et al. [35]	40 Lap	2.8 ± 1.7	180	40	12	5	1.3	NR
	40 Open	2.7 ± 1.4	127	162	18	50	1.3	NR
Thompson et al. [36]	60 Lap	2.9	167	NR	4.1	6	NR	3.8 weeks
	50 Open	2.9	127	NR	5.7	18	NR	7 weeks
Brunt et al. [31]	24 Lap	2.7 ± 1.4	183 ± 35	104	3.2 ± 0.9	NR	NR	NR
	25 Open	3.4 ± 1.4	142 ± 38	408	8.7 ± 4.5	NR	NR	NR

Studies comparing LA and OA found that patients with LA were able to return to a regular diet and resume normal activity earlier than patients with OA, and they were also able to leave the hospital earlier. Additionally, comparative trials that assessed analgesic requirements demonstrated that LA patients required significantly fewer analgesics than their OA counterparts, further supporting the benefit of a laparoscopic technique [35-37].

Patients undergoing LA tend to have less long-term surgical morbidity, likely due to the reduced size of their wounds. Patients undergoing OA for a variety of causes had a much greater risk of wound complications, reaching 54% in a posterior OA group, according to series with long-term follow-up [36]. Imai et al. [35] found a late wound complication rate of 47.5% in the OA group and zero in the LA group, lending credence to this conclusion.

Our go-to LA technique is the lateral transperitoneal approach. It gives a bigger work area and gives access to known anatomical markers [17, 38, 39].

Outcomes Analysis for Malignant Adrenal Masses

Primary Adrenal Malignancy

Adoption of LA for adrenal gland malignant neoplasms has been greeted with conflicting opinions. Glands rupturing and subsequent locoregional and port-site recurrence are the primary concerns [12, 40, 41].

Taking into account the effects of the resection margin status on survival and recurrence, the question of whether LA is oncologically sufficient for ACC excision remains open. We don't have enough published data to make a decision on this matter just yet. Methodological issues such selection bias, limited sample sizes, and brief follow-up periods make it hard to draw conclusions from the existing literature [42].

For smaller lesions (≤10 cm), a patient undergoing LA had similar oncological results compared to having an OA, according to a recent large study that compared 152 patients with ACC and LA (n = 35) with OA (n = 117) [43]. With respect to disease-specific survival, disease-free survival, tumor capsule violation, and peritoneal carcinomatosis, they came to same conclusions. Unfortunately, selection bias was a problem in this study because it tried to standardize patient groups.

In the past, researchers have looked at laparoscopic approaches treating adrenal gland cancers, both primary and secondary. Results with 18 instances of LA and 25 instances of OA in patients with Stage I and II ACC were shown to be equivalent by Porpiglia and colleagues [44], with similar disease-free survival rates [42, 44].

While the authors did find that LA is equivalent to OA from a cancer perspective in cases of localized ACC less than 10 cm, they did say that LA is warranted in cases of potentially malignant adrenal incidentalomas and in some Stage I and II ACC patients. Again, this requires caution in interpretation because the patients were drawn from a national registry that included numerous treatment centers and surgeons [42].

We recommend against LA for patients suspected of having ACC, regardless of how tiny the lesion is (<6 cm) [45, 46], because the results from the literature can be somewhat variable.

Secondary Adrenal Malignancy

There are a number of cancers that can spread to the adrenal glands, including non-small cell lung, gastrointestinal, renal, and melanoma [47]. Based on these findings, Kebebew and colleagues [45] suggest that laparoscopic surgery for suspected adrenal tumors could be useful for both diagnosis and treatment. Higher recurrence, possibly as a result of tumor leakage or inadequate resection, was similarly linked to LA for unexpected ACC, according to the same study. When it came to tiny, organ-confined adrenal metastases, Moinzadeh and Gill found that LA produced acceptable perioperative and oncological outcomes in their sample of 31 patients.

Regarding isolated adrenal metastases, Strong et al. [21] conducted a bigger investigation that contrasted OA with LA. Los Angeles improved intraoperative and perioperative outcomes, but there was no change in margin status, local recurrence, or overall survival.

In conclusion, it appears that the advantages of LA for certain instances of primary and secondary adrenal cancer are quite diverse. Hence, prior to the availability of more definitive information, the decision regarding the surgical strategy for adrenal tumors that may or may not be cancerous should be based on the surgeon's and center's level of expertise, the tumor's size, the likelihood of cancer and local invasion. Concerns about a satisfactory oncological resection should prompt the adoption of a low threshold for conversion if LA is to be the preferred technique, prior to the emergence of irreversible events such tumor capsule breach..

Other Considerations

Single Port Access Laparoscopic Adrenalectomy

Thanks to advancements in technology, single incision laparoscopic surgery (SILS) has become a viable option for a range of treatments. A customized laparoscope is inserted through a single, bigger laparoscopic port, and articulating devices are utilized. Reduced need for analgesics and superior cosmetics due to a single scar are two post-operative benefits [48, 49]. Despite the use of articulated instruments to reduce operator and assistant interference, there are still drawbacks such as spatial unfamiliarity, the demand and subsequent cost of specialized instruments, and port-site congestion.

Castellucci et al. [50] initially detailed the SILS adrenalectomy procedure in 2008. The effectiveness of SILS in adrenalectomy has been the subject of multiple follow-up studies and reports. When retraction of organs is

necessary, an extra port is often necessary. Comparing the results of SILS adrenalectomy with those of the more traditional laparoscopic method, Rane et al. [51] combed through the existing literature. They came to the conclusion that SILS required more time during surgery than the traditional laparoscopic method, but that patients needed less pain medication after the procedure. A major obstacle was the longer average operating time, which is due to a combination of operator and instrument level issues that might be better addressed with experience and updated technology.

Laparoscopic Retroperitoneal Adrenalectomy

Some have seen a laparoscopic retroperitoneal (LR) technique as a development of the conventional transperitoneal LA approach, due to the adrenal glands' typical placement in the upper retroperitoneal area. Without having to go via the peritoneal canal and avoid intra-peritoneal organs, a direct retroperitoneal route certainly grants quicker surgical access. There is less chance of ileus and less need for analgesia if there is no need to irritate abdominal viscera by entering the peritoneal cavity.

Under the supervision of a skilled surgeon, LR adrenalectomy can be safer and even quicker than a trans-peritoneal technique, according to a big series of 560 surgeries conducted by Walz et al. [52]. The peri-operative benefits first shown with the advent of transperitoneal LA versus OA were raised by an LR technique, as shown by Lee and colleagues [53]. In fact, pheochromocytoma [55, 56] and Conn's adenomas and hyperplasia [54] are additional indications that LR adrenalectomy is beneficial.

Conclusions

Over the past two decades, there has been substantial advancement in the laparoscopic transperitoneal technique for adrenal surgery. When compared to OA, the perioperative and operational results are either the same or better, and the procedure is safe and reproducible. In practically every facet of adrenalectomy, LA has supplanted OA. As time goes on and new methods of analyzing the effects of LA become available, we may expect to see even more variations on the theme.

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