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Posterior Retroperitonoscopic Adrenalectomy; How to Do it – Pearls and Secrets

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Abstract

Background: Since the early 1990s, endoscopic adrenalectomy has become the gold standard surgical approach for the adrenal gland. Also, lateral transperitoneal adrenalectomy (LTA) which is the most widely used approach accompanies that.. Posterior retroperitonoscopic adrenalectomy (PRA) is another safe and effective approach for the adrenal gland. However, it has not gained global popularity. This is largely attributed to the unfamiliarity of surgeons with the ergonomics and executional steps of the procedure, and the relevant retroperitoneal anatomy. Misconceptions held by both surgeons and anesthesiologists regarding the consequences of the high-pressure retroperitoneal insufflation required may also be a contributing factor. The aim of this article is to provide a detailed description of PRA in a manner which allows the proper acquisition of the knowledge required to perform the procedure safely and effectively.

Methods: To achieve the objective of this article, it has been broadly divided into three sections including background, operative technique, and comments. The background provides an introduction to the procedure and its advantages. The section about operative technique provides a detailed description of the preoperative preparatory phase, the proper access, and the executional steps of the procedures supplemented with illustrative figures. It also provides insight into potential hazards related to the anatomy of the adrenal veins, and the means of dealing with variant anatomy. The comments' section deals with the procedure's learning curve, and the factors affecting it. It also describes the ideal case for the commencement of the learning curve. A clarification of the misconceptions surrounding PRA is also provided in this section.

Conclusion: With thorough technical knowledge and an adequate learning curve, PRA could serve as the surgeon's preferred surgical approach to the adrenal gland within the confines of its selection criteria.

Keywords: Retroperitoneoscopic Adrenalectomy, Posterior Retroperitoneoscopic Adrenalectomy, Retroperitoneal Adrenalectomy, Minimally Invasive Adrenalectomy

1. Background

Ever since its standardization in 1994, posterior retroperitonoscopic adrenalectomy (PRA) has become the preferred surgical approach to the adrenal gland within the confines of its selection criteria (1-3). PRA offers a direct anatomical access to the adrenal gland, and a target-oriented dissection. It avoids mobilization of adjacent structures and violation of the peritoneal cavity manifesting the true essence of minimally invasive surgery. The favorable surgical outcomes of PRA over lateral trans peritoneal adrenalectomy (LTA) have been demonstrated in terms of reduced operative time, reduced time to oral intake and ambulation, reduced postoperative pain, and reduced hospital stay (3-5). These provide further testimony to its true minimally invasive nature. Furthermore, PRA is more appealing than LTA in patients with previous abdominal surgery and/or bilateral adrenal disease. Despite of its safety, effectiveness and potential for offering additional advantages, PRA has been gaining popularity very slowly. This is mainly attributed to the unfamiliarity of surgeons with the ergonomics and technical details of the procedure, and the relevant retroperitoneal anatomy, as well as misconceptions held by both surgeons and anesthesiologists regarding the consequences of the high-pressure retroperitoneal insufflation required to perform the procedure. Therefore, the main objective here is to provide a detailed description of PRA in a manner that allows proper acquisition of the knowledge required to perform the procedure safely and effectively.

2. Operative Technique

The operative technique was according to the references (1, 2, 6, 7).

2.1. Anesthesia and Patient Preparation

The procedure is performed under general anesthesia. A nasogastric tube is placed routinely. A urinary catheter is

not routinely inserted for two reasons: the relatively short operative time, and the reduction in urine output following retroperitoneal insufflation. This may give the anesthesiologist a false sense of insecurity. Patients with pheochromocytoma require an arterial line and a central venous catheter. Antibiotic prophylaxis is done in the form of a single dose of Cefazolin (2 - 3 gm based on the patient's weight) intravenously. Venous thromboembolic disease (VTED) prophylaxis typically in the form of intermittent pneumatic compression is routinely used because the patient's position during the procedure involves compressing the iliac and femoral veins. Furthermore, the IVC is also compressed by the elevated retroperitoneal pressure. Nevertheless, VTED following PRA has not been reported.

2.2. Patient's Position

The patient is placed prone in a half-jackknife position, with the hip joints and knees bent at 75 - 90° and fixed in this position (Figure 1). The purpose of this position is to create an adequate working space between rib 12 and the iliac crest. The back should be flat (no lordosis). This allows sagging of the abdomen which in turn allows the abdomen to adequately accommodate viscera when the retroperitoneal pressure rises, maintaining the working space created in the retroperitoneum. This is done by placing two towel rolls one beneath the lower thorax and another across the iliac crests. Alternatively, a surgical cushion/stomach support could be used for this purpose (Figure 2).

Figure 1. Patient's Position in Posterior Retroperitonoscopic Adrenalectomy

The operating table here supports proper positioning of the hip joints and knees.

Unlike other surgical procedures, the patient should not be centered on the operating table. Instead, the patient's lateral abdominal wall on the side destined for surgery, should be placed in line with the edge of the operating table to allow the free movement of instruments during the procedure. However, if both sides are to be operated upon simultaneously (concordant bilateral retroperitonoscopic adrenalectomy; COBRA), the patient should be placed in the center of the table.

Figure 2. Stomach cushion; Its Use is Very Helpful in Allowing Sagging of the Abdomen During Posterior Retroperitonoscopic Adrenalectomy.

2.2.1. Trouble Shooting

Occasionally, the available operating table does not support proper positioning of the patient (i.e. hip joints being bent at 75 - 90°). This could be easily resolved by removing part of the operating table (leg support) and replacing it with a chair.

2.3. Instruments

In most cases, a 5 mm 30° camera provides a satisfactory view. Dissection is carried out using Bipolar Scissors (LigaSure® 5 mm blunt tip 37 cm). Bipolar scissors are preferred over ultrasonic shears because the amount of surgical smoke generated by the latter, obscures the surgeon's vision in the available limited working space.

2.4. Port Placement

Classically, a 1.5 cm incision was made just below the tip of rib 12 and the retroperitoneal space is then entered sharply using scissors, and a 10 mm port was placed. However, as the position and orientation of rib 12 related to the operative field varies among individuals due to variations in body habitus, a more appropriate way of placing the first port is midway between the spine and lateral abdominal wall just below and parallel to rib 12. Placement of the second port (5 mm) is digitally guided and does not require

visual control; the tip of rib 11 is palpated with the index finger and the port is placed just lateral and below the tip of rib 11 in line with the first port. The third port (5 mm) is placed only after creation of the working space and visualization of the kidney to avoid inadvertent entry into the thorax.

2.4.1. Creation of the Working Space

With the scope in port 1 and a grasper in port 2, CO_2 insufflation is started at 20 mmHg and can be raised to 30 mmHg if required, as in obese patients. The space below the diaphragm is created by displacing fatty tissue downward until the upper pole of the kidney is visualized (Figure 3).

2.4.2. Placement of the Third Port (5 mm)

This is done under direct vision. The port is inserted lateral to the paraspinous muscles, parallel to the spine and is directed cranially, at an almost flat angle to the skin. There are two reasons for this special technique of port placement. First, it should always be remembered that the adrenal glands are found in close proximity to the spine, and that the third port (medial port) will ultimately serve as the camera port. Accordingly, such port placement allows direct visualization of the gland. Second, this technique minimizes the risk of subcostal nerve injury whether during port insertion or during the procedure as the port tends to be fixed at the gland and not freely mobile. With the use of this technique for port placement, the reported incidence rate of subcostal nerve injury is only around 10% and is transient. This is significantly favorable compared to its conventional posterior counterpart. Eventually, all three ports are situated along a straight line just below Rib 12 (Figure 4).

2.4.3. Alternative Technique for First and Second Port Placement

After making a 1.5 cm incision midway between the spine and lateral abdominal wall, a 10 mm port cannula (without trocar) is pushed directly into the retroperitoneal space. It should be remembered that the distance to the retroperitoneal space is about 1.5 cm and that entry into the space is accompanied by the sensation of “loss of resistance”. Entry into the retroperitoneum should be controlled by applying opposing forces on the cannula. Extra care is required in Cushing’s patients due to tissue friability in this subgroup of patients. The second port is placed under vision after creation of the working space.

Both sides can be operated on simultaneously by two surgical teams (COBRA). In such cases, an equal pressure should be maintained on both sides at all times even if the intervention is over on one side. Pressure differences allow the compression or decompression of one side or the other one.

2.5. Dissection and Resection

At the commencement of dissection, the medial port should serve as the camera port, and the middle and lateral ports are for the surgeons’ working hands. The kidney should be retracted downwards by an instrument in either the middle or lateral port. Sometime, placement of an additional port, below the line of existing ports, may be required for retracting the kidney. The adrenal gland is mobilized medially (3 O’clock to 9 O’clock direction) and caudally (along the plane between the lower border of the adrenal gland and the superior border of the kidney). On the right side, the adrenal arteries are seen crossing the posterior surface of the IVC. Dividing the adrenal arteries, frees the confluence of the adrenal vein and the IVC. The gland is then lifted off the IVC exposing the adrenal vein that enters the posterior aspect of the IVC (Figure 5).

On the left side, dissection starts in a similar manner. The vein is prepared in the area between the adrenal gland and the left hemidiaphragm medial to the upper pole of the kidney; the area where the adrenal arteries are found (Figure 6). The middle adrenal artery typically covers the confluence of the adrenal and inferior phrenic veins (8). The vein is then divided and dissection is completed while lifting the gland from the venous stump. Care must be taken to identify and preserve a superior polar artery (to the kidney) that is present in 20% - 30% of individuals. On the left side, extended mobilization of the upper pole of the kidney is essential as the lower pole of the adrenal gland lies in front of the kidney.

In PRA, division of the adrenal veins is done towards the end of the procedure. This contradicts the vein-first dogma. Controlling the vein first especially in cases of pheochromocytoma, was considered as the golden rule to prevent catecholamine surges related to gland manipulation. However, it has been demonstrated that delayed division of the vein is as safe as dividing it first (9-11). Delayed division of the adrenal vein does not significantly increase hemodynamic changes during endoscopic adrenalectomy via the lateral transperitoneal or the posterior retroperitonoscopic approach. Thus, the vein-first dogma is no longer valid.

At this point, it is worth emphasizing that in PRA, the aim is to dissect the superior pole of the kidney and thus, the adrenal gland is dissected en bloc with its surrounding fatty tissue. It is not itself targeted nor is it necessary to clearly visualize it. It should also be re-emphasized that dissection is carried out medially and caudally. The cranial aspect of the gland is dissected towards the end of the pro-

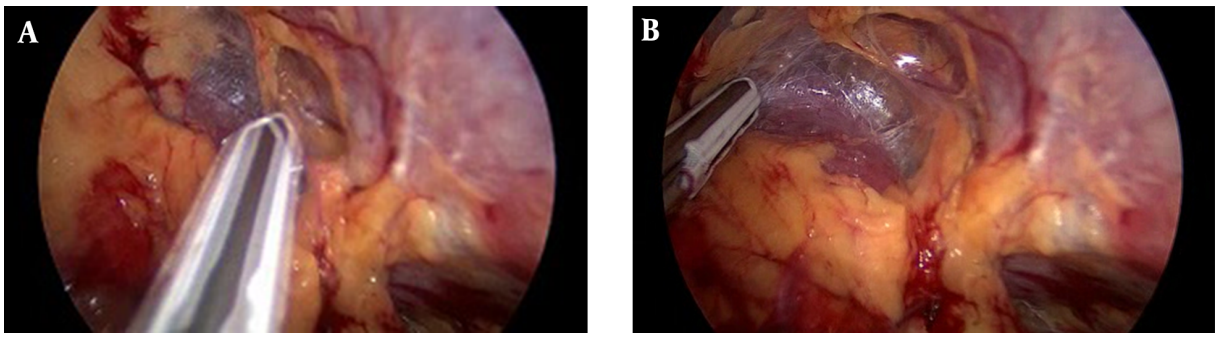
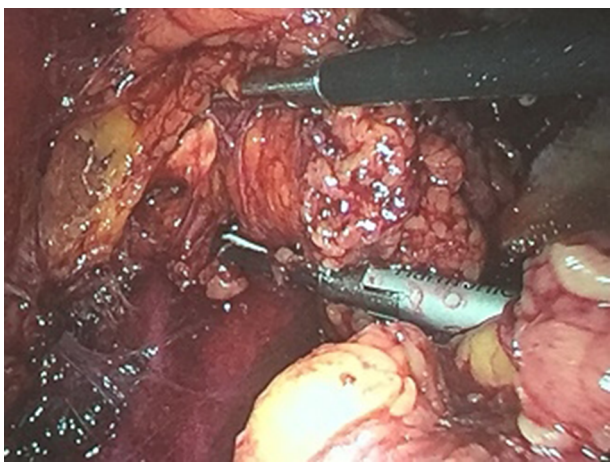


Figure 3. Preparation of the A, Working Space; B, Entry Into Gerota's Fascia Displacing the Fatty Tissue Downward Until the Upper Pole of the Kidney is Visualized.

Figure 4. Final Port Position; All Ports are Aligned Just Below and Parallel to Rib 12.

Figure 5. On the Right Side, the Upper Part of the Adrenal Gland Lies Partially Behind the IVC and the Adrenal Vein Exits Below the Apex



Therefore, once the gland is lifted off the IVC, the adrenal vein can be seen entering its posterior aspect (the tip of the energy device). This requires dividing the adrenal arteries that are found inferomedially crossing the posterior surface of the IVC.

Figure 6. On the Left Side, the Adrenal Vein (the Tip of the Energy Device) is Exposed in the area Between the Adrenal Gland and the Left Hemidiaphragm Medial to the Upper Pole of the Kidney

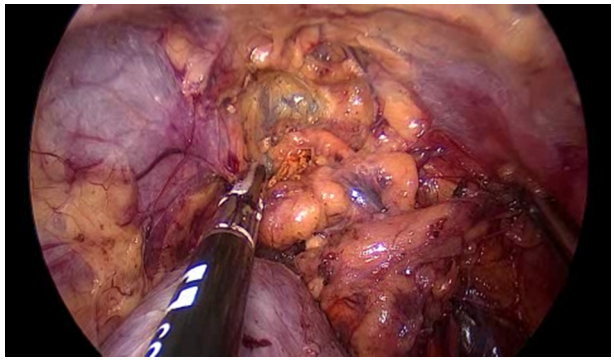
The left adrenal vein is typically joined by the inferior phrenic vein before draining into the left renal vein. The inferior phrenic nerve could be safely preserved.

cedure so that it would serve as a natural means of retraction during the procedure (Figure 7).

2.5.1. Potential Hazard Related to the Anatomy of the Adrenal Veins

Detailed knowledge of surgical anatomy is the key to a successful surgery. In PRA, this becomes clearly evident when considering anatomy of the adrenal veins particularly the one on the right. The anatomy of the left adrenal vein is usually constant and is typically joined by the inferior phrenic vein before draining into the left renal vein. The inferior phrenic vein could be preserved in most instances. On the other hand, anatomic variants of the right adrenal vein exist in about 13% of cases and have been found to be related to certain patient- and tumor- related features (12). Anatomic variations include: the absence of a main adrenal vein, the presence of additional small veins, and a double adrenal vein (12). The right adrenal vein

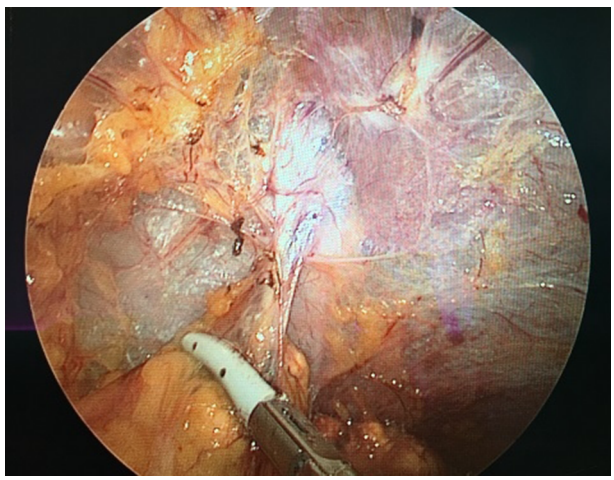
Figure 7. Left Side; Dissecting the Cranial Attachment of a Adrenal Gland Towards the End of the Procedure



The superior pole of the kidney is seen below the energy device, and the caudal aspect of the adrenal gland and its surrounding fat have been completely dissected free from it.

sharing confluence with an inferior accessory right hepatic vein has also been reported (7, 13). In the experience of the developer of PRA (Dr Walz), the greatest potential hazard is related to misidentification of the right adrenal vein; mistaking it with a posterior hepatic vein (14). In situations where the adrenal vein is not identified with certainty, a useful tip is to complete the dissection of the gland without dividing the vein. In other words, the gland is left hanging only from its vein (Figure 8). A complete understanding of the anatomic variations in the drainage of the right adrenal vein is paramount for the safe performance of endoscopic adrenalectomy.

Figure 8. The Right Adrenal Gland Suspended Only From Its Vein; This is a Useful Technique in Situations Where an Adrenal Vein is Confused With a Posterior Hepatic Vein

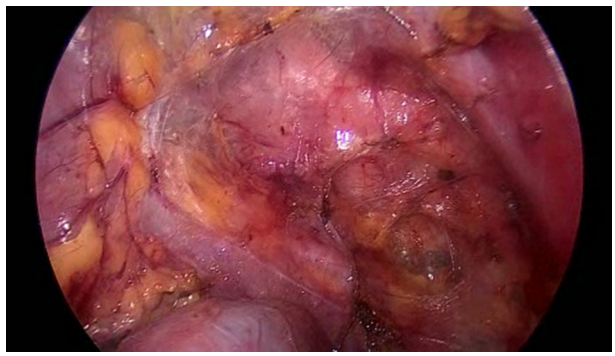


The background demonstrates the blue tinge of the peritoneum overlying the liver.

2.6. Concluding the Operation

The field is routinely irrigated and hemostasis is secured at a low pressure to prevent any tamponade effect of high retroperitoneal pressure (Figure 9). Drain placement is not routinely required. It could be placed following partial adrenalectomy when a potential risk of remnant bleeding exists. The specimen is retrieved in an endobag via the middle port that might need to be enlarged (Figure 10). Occasionally, specimens need to be morcellated for successful retrieval. The patient is allowed oral intake upon full recovery from anesthesia, and ambulation encouraged. Occasionally after long interventions, the patient's skin may become erythematous all the way up to the face. This is not worrisome. It is only transient and resolves completely within a few hours after desufflation. Patients' informed consent was obtained regarding the use of photos related to their surgeries for scientific purposes.

Figure 9. Final View of the Operative Field Following Resection of the Left Adrenal Gland



The background represents the peritoneum overlying the stomach and spleen. Drains are not routinely required.

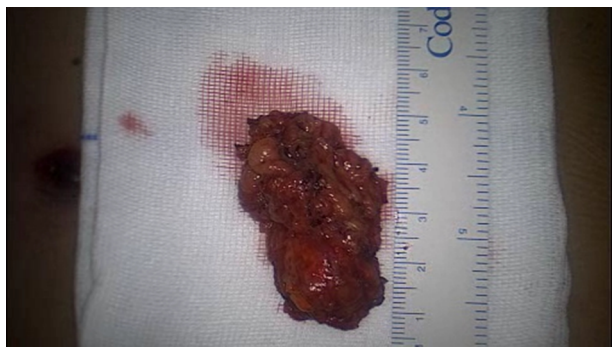


Figure 10. The Adrenal Gland Resected en Bloc With Its Surrounding Fatty Tissue.

3. Comments

A learning curve is a graphical representation of performance improving with experience in four phases. Accordingly, performance tends to improve with experience, and one of the measures used for its assessment is operative time (15). In RPA, surgeons experienced in laparoscopic surgery attain an adequate level of proficiency and safety performing the procedure after 10 - 15 cases. This is similar to the learning curve of LTA. However, surgeons seem to become trapped in the second phase of the learning curve (curve ascent), as a continuous reduction in operative time has been demonstrated even after 500 procedures performed (1). Factors that significantly prolong operative time include: right sided procedures, male sex, lesions > 3 cm in size, and pheochromocytomas. The effect of these factors (except for the first) on operative time does not seem to revert even after attaining proficiency performing the procedure (1, 11). Surgeons at the start of their learning curve are advised to be highly selective. An ideal case would be a female, with a BMI in the normal range, and a small, left-sided, non-pheochromocytoma lesion. Obesity itself is not a contraindication to PRA. However, super-obesity (BMI > $45Kg/m^2$) is. In super-obese individuals, abdominal viscera compress the retroperitoneum limiting the available working space, and high insufflation pressure is unlikely to compensate for this drawback.

Surgeons and anesthesiologists may be reluctant to adopt PRA because of the mistaken belief that the high-pressure retroperitoneal insufflation used during the procedure is more likely to have significant adverse hemodynamic effects. However, it has been demonstrated that intraperitoneal and retroperitoneal CO_2 insufflation evoke different cardiovascular changes, and that high retroperitoneal insufflation pressure does not cause significant hemodynamic changes and is well tolerated (16, 17). High-pressure retroperitoneal insufflation is also theoretically incriminated for a higher risk of VTED and gas embolism. Nevertheless, these potential complications have not been reported in literature (1-4).

Adhering to selection criteria cannot be overemphasized as it is one of the keys to successful surgery. Lesions > 7 cm in size are considered a contraindication to RPA. This is because the risk of malignancy of an adrenal lesion is directly proportional to its size. So, it is the technical difficulty handling the lesion and the risk of capsule rupture. Nevertheless, with sufficient experience, this contraindication tends to become only relative. Other contraindications include: super-obesity, concomitant intra-abdominal pathology requiring surgery, and a short distance (< 4 cm) between rib 12 and the iliac crest.

In conclusion, PRA is a minimally invasive and maximally effective procedure performed via a minimal access that can only be appreciated by thorough technical knowledge and an adequate learning curve. Although being surrounded by skepticism and gaining gradual popularity, the authors believe that it has the potential to evolve dramatically and become the surgeon's preferred tool for managing adrenal pathology.

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Footnote

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