Case Report

A Laparoscopic Comparative Study of Right and Left Adrenalectomy – A Case of Non-Identical Twins: Two Case Reports with Review of Literature

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A B S T R A C T

Introduction: The different anatomies of the right and left adrenal glands make them a textbook case of non-identical twins. The divergent course of the main blood vessel namely the adrenal vein as well as the widely contrasting anatomy of the surrounding organs on the right versus the left sides practically make right and left adrenalectomy what they are - two different operations with the same name !

Case report: In this paper, we endeavor to make a side by side pictorial comparison of laparoscopic right and left adrenalectomy vis-à-vis their pre-operative radiology and the important steps of their laparoscopic resection, the most important being the dissection, identification, skeletonization and control of the right and left adrenal veins. Also we summarise a comprehensive review of literature that attempts to cover all the dimensions of minimal invasive adrenalectomy.

Conclusion: Laparoscopic adrenalectomy is now considered the gold standard for treatment of most adrenal gland pathologies.

Keywords: A Laparoscopic Comparative Study, Right and Left Adrenalectomy, Non-Identical Twin

INTRODUCTION

The adrenal glands were first described by Bartholomaeus in 1552, as glands lying on the kidney. The left adrenal gland is semilunar in shape whereas the right gland is triangular. In 1805, Cuvier described the anatomy of the adrenals as cortex and medulla. These glands are chiefly responsible for releasing hormones in response to fear, flight and fright through the synthesis of corticosteroids like cortisol and catecholamines like nephrine and metanephrines. These glands also play an important role of regulating blood plasma osmolarity through the action of aldosterone on the kidneys. Surgery of the supra-renal glands is considered difficult due to their deep retroperitoneal location and close proximity to important anatomical structures. The world's first planned open trans-peritoneal adrenalectomy was performed in 1914 by Sargent. Mayo performed the first flank approach adrenalectomy for phaeochromocytoma in 1927. Since its inception in 1992(Gagner), laparoscopic adrenalectomy was rapidly and widely accepted due to the difficult anatomical location of the gland and the relative ease of the laparoscopic versus open approach, in its surgical excision. Due to this and the other obvious benefits like lesser requirement of analgesia, shortened hospital stay, faster recovery, better cosmesis and the fact that it has significantly reduced mortality and morbidity associated with the open technique by minimizing intra and post operative significant hemorrhage; laparoscopic adrenalectomy has swiftly climbed the pedestal of being the gold standard for adrenal excisions, for most pathologies.

CASE REPORTS

Case -1: A 35 year old male with no comorbidities presented to the surgery out patient department with complaints of non-specific and vague abdominal pain since the last two months, not associated with any other symptoms.

On physical examination, his pulse rate was 86 beats per minute, respiratory rate 18 breaths per min, blood pressure was 130/80 mmHg and he was afebrile. A per abdominal examination revealed mild tenderness in the right lumbar region. His laboratory reports revealed : hemoglobin - 14 gm/dl, WBC - 9000/microlitre, platelets - 2.2 lakhs/ microlitre, sodium – 136 mEq/ L, potassium – 4mmol/L and creatinine – 0.8ml/dl. A contrast enhanced computed tomography(CECT) scan of the abdomen revealed a large non contrast enhancing right adrenal mass measuring 9 centimeters in diameter, most likely to be a myelolipoma (Fig 1A). The patient was then worked up to rule out functional adrenal tumours. He was subjected to the low

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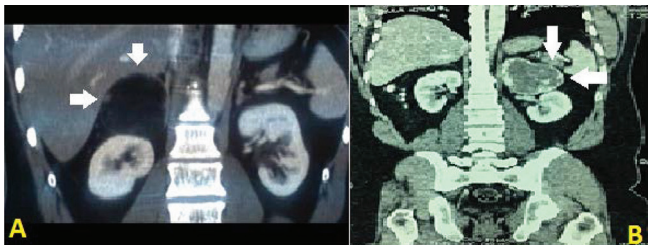

Figure-1: CECT appearances: A – right side : Coronal view showing non enhancing right adrenal myelolipoma, B – left side : Coronal view depicting an enhancing left adrenal mass

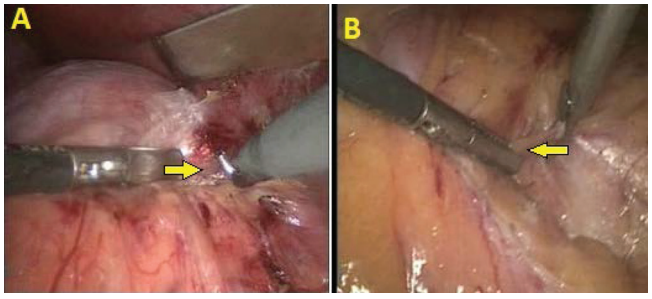

Figure-2: Initial steps of dissection: A - right side : division of posterior parietal peritoneum just below the liver at the superior aspect of the mass, B – left side : medial reflection of descending colon from over the the left Gerota's fascia

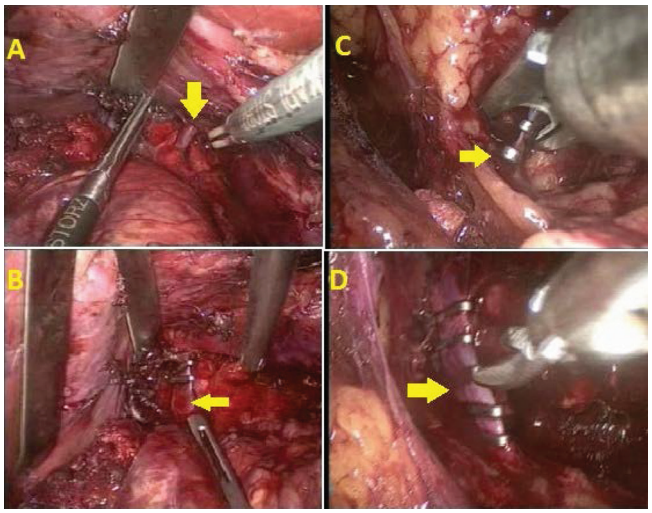

Figure-3: Dissection & control of the adrenal vein : A&B-right side:skeletonised & clipped short, stubby right adrenal vein draining directly into the IVC, C&D-left side: clipped longer right adrenal vein draining into the renal vein about to be divided

dose dexamethasone suppression test, which showed a serum cortisol value of 1.2 mcg/dl (1.8 mcg/dl is the recommended cut off value for diagnosing Cushing's syndrome). The plasma fractionated metanephrine level was 42 pg/ml, serum DHEA (Di-hydro- epi-androsterone) levels were 6 ng/ml and the urinary cortisol level was 15 mcg/ 24 hours.

Thus a diagnosis of a non functioning incidentaloma - myelolipoma, was made and the patient underwent a laparoscopic transabdominal right adrenalectomy by flank approach. The histopathology report confirmed a myelolipoma. The postoperative recovery was uneventful and

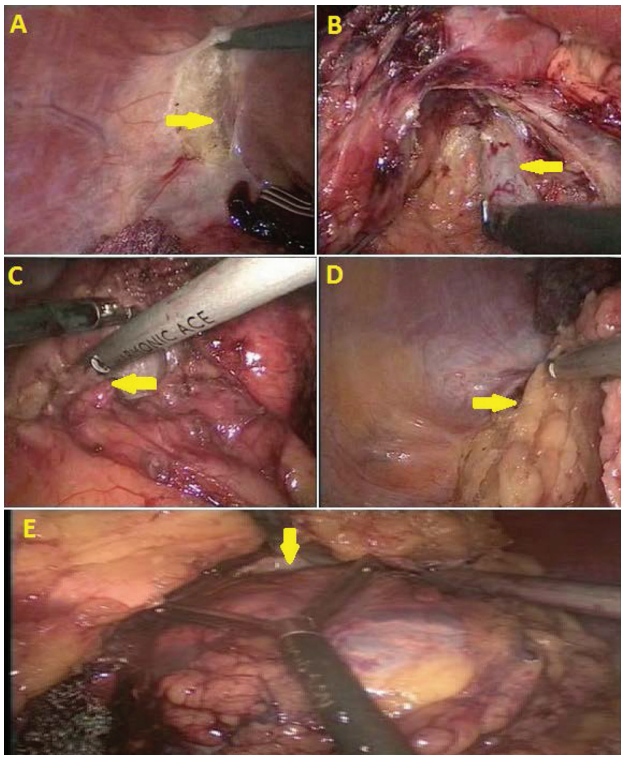

Figure-4: further steps of lap. right adrenalectomy : A) division of the right triangular ligament of liver, B)entry into the space between IVC and the right adrenal gland, C) dissection inferior to the right tumour at the superior pole of right kidney, D)lateral dissection, E)superior dissection

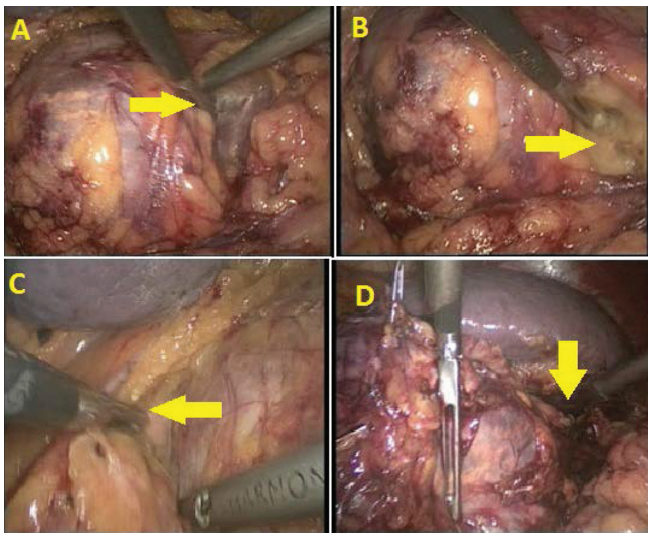

Figure-5: further steps of lap. left adrenalectomy – A) inferior dissection at the superior pole of left kidney, B) lateral dissection, C)medial dissection, D)superior dissection

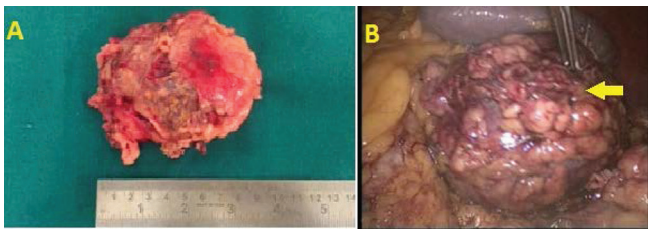

Figure-6: Excised adrenalectomy specimens : A) right myelolipoma, B) left non functioning pheochromocytoma

Sr. No.	Author/s [Ref. No.]	Journal(yr. Of publication)	No.of patients	Type of study	Methods/ Results	Conclusions
1.	Stephen E Burpee, Gregg H Jossart, Michel Gagner[14]	Surgical Treatment: Evidence-Based and Problem-Oriented: Book (2001)	*Series of lap adr.: 1052pt.(1082 procedures) *Lap vs Open series : Lap-228pts. Open-242pts./276 procedures *Trans vs Retroperitone-al series : Transperitone-al : 118pts. Retroperitoneal : 773pts.	Book chapter: Comparative study of multiple series (compa-rison of indications, open vs lap & trans vs retroperiton---eal approaches)	*Various concerned published series studied & summarised on the basis of their outcomes *studies based on op. time, length of stay, blood loss, conversions, other complications, male vs female pts., indications etc.	*Lap adr safe & effective *Lateral transperitoneal approach more common than retroperitoneal *blood loss & length of stay less in lap than open *overall complications lesser in lap *outcomes similar between trans & retroperitoneal series *Posterior retroperitoneal approach can avoid adhesions frm previous abdominal surgeries & saves time in B/L adrenalectomies as pt. does not have to be re-positioned *However it has a steeper & longer learning curve due to unfamiliarity of anatomy & restricted working space *open adr. has a role in very large tumors & obvious malignancy *In larger tumors, transperitoneal approach is clearly superior to retro.
2.	J Marescaux, D Mutter, M H Wheeler[18]	Surgical endoscopy (1996)	27	Case series	*18women & 9men *mean age-50.8y *12rt & 15lt glands removed *transperit. flank approach-26 retroperit. flank approach-1 *median gland size-2cms *avg. op. Time-140mins *avg. hosp. Stay-4.6d	*Lap adr. is safe and offers fast recovery and short in-hospital stay *Laparoscopic adrenalectomy combines the advantages of both the conventional anterior and posterior approach

Table-1: ***Continue***

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3.	M Gagner, A Pomp, B T Heniford, D Pharand, and A Lacroix[15]	Annals of surgery (1997)	100	Clinical trial	*88pts, mean age-46y *55pts. had prev. abdo. surgery *mean op. time-123mins *mean bld loss-70ml *conversions to open-3 *avg. Length of stay-2.4 d *during follow up 2 had renovascular hypertension & none had recurrence of hormonal excess *during phaeo. Excision 56% had hypertension & 52% had hypotension *Phaeos.(25) Aldosteronomas(21) Non-func. adenomas(20) Cortisol producing adenomas(13) Cushing's disease(8) Others(13)	*Lap adr. is safe, effective, decreases hospital stay and wound complications *Prior abdominal surgery is not a contraindication *Pheochromocytomas can be resected safely laparoscopically despite blood pressure variations * Venous thrombosis prophylaxis is mandatory *The lap approach is the procedure of choice for adrenalectomy except in the case of invasive carcinoma or masses > 15 cm
4.	Matthew J. Mellon, Amanjot Sethi, and Chandru P. Sundaram[16]	Indian journal of urology (2008)	Not applicable	Narrative review article	Indications, contraindications,instr-umentation & pt.positioning discussed in rt.& lt.adr. vis-a-vis lateral transperitoneal, lat. retroperitoneoscopic, posterior retroperitoneoscopic approaches. Also lap B/L adr, lap partial adr touched upon & complications summarised	*Lap adr. is a safe and effective technique for the surgical removal of adrenal masses *Clear advantages over open resection
5.	Umberto Maestroni, Stefania Ferretti, Francesco Ziglioli, Davide Campobasso, Dario Cerasi, Pietro Cortellini[7]	Urologia (2011)	6	Case series	*Adr masses between 7-15cms *Mean operating time-120mins *Mean blood loss-50ccs *Discharge on POD3	*No postop. complication *Safe and effective also in the case of giant masses *Preoperative diagnosis has a predominant role to determine the contraindication of this technique (invasive adrenal carcinoma)
6.	J J Soble, I S Gill[13]	Urology (1998)	39(42 procedures)	Clinical trial (needlescopi-c adrenalectom-y)	*3 converted to conventional lap. & 1 to open *avg.op.time-132mins *avg.bld.loss-67ccs	*Initial experience-promising *In select pts.-safe & feasible *Further evaluation & improvement in 2mm instrumentation & optical technology required

Table-1: ***Continue***

7.	M K Walz, K Peitgen, M V Walz, R Hoermann, B Saller, R M Giebler, F Jockenhövel, T Philipp, C E Broelsch, F W Eigler, K Mann[11]	World journal of surgery (2001)	130(142 proced-ures)	Case series-prospective review	*tumor size range 0.5-7cms *Partial adr. in 39 pts. *conversion to open in 5pts.&7pro. *Op.time 101+/-39mins *blood loss 54+/-72ml *low requirement of analgesics *mean hosp. Stay – 3 days	Posterior retroperitoneoscopic adrenalectomy is a safe method & has become a standard procedure in endocrine surgery
8.	I S Gill, A M Meraney, J C Thomas, G T Sung, A C Novick, I Lieberman[20]	The journal of urology (2001)	3	Case reports	*All 3 pts had significant prior abdominal scarring after either partial or total radical nephrectomy, thereby precluding efficient transabdominal laparoscopic access *Double lumen endotracheal intubation *4 port trans-thoracic approach *Diaphragm incised under real time lap USG guidance *after excision of gland, dia. suture closed *mean op.time-4.5hrs *mean bld loss-234ccs *hosp.stay-2days	In select patients with significant concomitant intra-peritoneal and retroperitoneal scarring from prior major abdominal or renal surgery, laparoscopic adrenalectomy can be safely performed with the trans-thoracic trans-diaphragmatic approach

Table-1: Summary of review of literature concerning the various dimensions of minimal invasive adrenalectomy

he was discharged on post operative day(POD) 3.

Case -2 : A 41 year old male presented to the surgery out patient department with complaints of left sided pain in abdomen since 6 months which was dull aching in nature, not associated with nausea and vomiting. On clinical examination, his pulse rate was 82 beats per minute, respiratory rate was 16 breaths per min and blood pressure was 120/70 mmHg. He was afebrile. A per abdomen examination revealed mild left loin tenderness. He did not have a palpable abdominal lump and had no clinical evidence of free fluid in the abdomen. His blood investigations revealed a hemoglobin of 14.4 gm/dl, WBC - 7300/microlitre, platelets - 2.4 lakhs/microlitre, sodium – 140 mEq/ L, potassium – 4.2 mmol/L and creatinine – 0.7 ml/ dl. A CECT scan of the abdomen revealed a large contrast enhancing left sided adrenal mass measuring 8.6 cm in diameter which was partly cystic in appearance(Fig 1B). The endocrine workup revealed a serum cortisol value of 1.0 mcg/dl on low dose dexamethasone suppression test, plasma fractionated metanephrine level was 36 pg/ml, serum electrolytes were within normal range, serum DHEA level was 3 ng/ ml and the urinary cortisol level was 11 mcg/ 24 hours; thereby suggesting that it was a non functioning adrenal mass. He underwent a laparoscopic transabdominal left adrenalectomy by flank approach. The histopathology report revealed a phaeochromocytoma. Thus the patient turned out to be a rare case of non-functioning phaeochromocytoma. His post operative recovery was uneventful and he was discharged on POD 5.

DISCUSSION

The adrenal glands are situated on supero-medial poles of each kidney in the retroperitoneum. Right adrenal gland is triangular and the left adrenal is a crescent shaped structure. The adrenal glands are located in front of the 12th rib on the right, in front of the 11th and 12th ribs on the left and on the lateral edge of the vertebral column at the level of 12th thoracic vertebra. Each adrenal gland is composed of a cortex and medulla, both of which secrete hormones. The adrenal cortex is divided into three parts secreting different hormones, namely:- 1) Zona glomerulosa - mineralocorticoids, Zona fasiculata - glucocorticoids and Zona reticularis - androgens. The adrenal medulla secretes catecholamines like epinephrine and norepinephrine in response to stress.

Each gland is supplied by three groups of vessels : 1) superior adrenal arteries derived from the

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inferior phrenic artery, 2) the middle adrenal arteries derived from the aorta and the 3) inferior adrenal arteries are derived from the renal artery. Each adrenal is drained by a single adrenal vein. The right adrenal vein is usually short (5mm in length) and drains directly into the IVC, while the left adrenal vein is longer (30 mm in length) and empties into the left renal vein after joining the inferior phrenic vein.

Indications of adrenalectomy are : incidentaloma more than 4 cms in size, aldosteronoma, pheochromocytoma, myelolipoma, adrenal cyst, Cushing's adenoma etc. For non-functional adrenal tumors, the indication for surgery is the risk of malignancy-according to the lesion size. If the tumor is less than 4 cm, the risk of malignant conversion is approximately 2%. For lesions ranging from 4–6 cm, the risk of malignancy is around 6%, while for lesions larger than 6 cm, the risk of malignancy is increased significantly to 25%.[1] The differential diagnosis of a supra-renal gland mass comprises of adrenal adenoma, adrenal cyst, adrenal myelolipoma, pheochromocytoma, adrenal cancer, metastatic cancer, hyperplasia, incidentalomas and tuberculosis. All the patients with adrenal mass should undergo all the hormonal, biochemical and localizing investigations. The goal of initial workup is to differentiate the benign lesion from the metastatic disease and also to distinguish between a non functioning tumor from the hyper- functioning lesion. The biochemical and hormonal tests advocated are – a)Dexamethasone Suppression Test: the sensitivity and specificity of this test ranges from 90- 100% in establishing a diagnosis of Cushing's syndrome. The cut- off values range from 50-138 nmol/L to diagnose adrenal disorder, b)24 hour urinary catecholamines and vanilmandelic acid levels is best utilized for diagnosing a case of pheochromocytoma, with sensitivity and specificity being 95%.[2] But the best test for diagnosing pheochromocytoma is the more recent addition to the screening modality known as the Fractionated plasma metanephrine levels, c)Plasma aldosterone and plasma renin levels should also be assessed in hypertensive patients presenting with adrenal lesions to see for Conn's disease & d)Sex hormone levels like dehydroepiandrosterone should also be evaluated to rule out rare adreno-cortical cancer producing symptoms of virilisaton and feminization.

The imaging modalities most commonly and effectively used for identifying different types of adrenal masses are a) Contrast enhanced computed tomography(CECT) - most of the adrenal lesions like the cyst, myelolipomas, adenomas, carcinoma and hemorrhage can be identified using this modality. Differentiation is made between adenoma and carcinoma on the basis of Hounsfield units. Lesions with a low attenuation value of less than 10 units are considered to be adenomas and lesions above 18 units are typically considered carcinomatous.[3,4] However CECT scans cannot distinguish between functioning and non-functioning lesions, b)Magnetic resonance imaging(MRI) - it is the investigation of choice for diagnosing adrenal mass. MRI is costlier in comparison to CECT but avoids exposure to ionizing radiation. Adenomas usually have low signal enhancement on T2 weighted images whereas pheochromocytomas have a bright (Electric bulb sign) signal intensity on T2 weighted images. Recently, chemical shift MRI has been used to distinguish between benign and malignant lesions. Benign lesions have a high lipid content and typically show a loss of signal intensity i.e they darken on the chemical-shift whereas malignant lesions show no loss of signal intensity, c)Adrenal scintigraphy - This is another method used to differentiate between benign and malignant lesions. This is done using metaiodobenzylguanidine(MIBG).[5] MIBG scan is especially used for pheochromocytomas that take up MIBG in adrenal vesicles. A normal adrenal gland has very few adrenal vesicles to pick up MIBG and hence cannot utilize it to produce an image. However a pheochromocytoma, has extra vesicles and will take up enough MIBG to produce an image on scintigraphy. Hence, MIBG scintigraphy is useful in localizing recurrent tumors or hormone secreting pheochromocytomas & d) Positron emission tomography(PET) - the differentiation of malignant and benign adrenal tumors can also be facilitated with the help of PET scan. The 18-FDG PET is based on the increased uptake of glucose by the high metabolic activity of lesions.[6] The use of PET is best reserved for cases in which CT imaging and clinical symptoms are inconclusive.

The decision for surgical management depends on several factors including size, functionality, malignant potential and overall clinical status of the patient. Management of incidentalomas between 4 and 6 cm is more controversial. The risk of malignancy in this size range is estimated to be only 6% and the risk of adrenal carcinoma is less than 2% in lesions <4 cm in size. Whereas, the chances of malignant conversion in lesions >6 cm is significantly higher, approximately 25%.[1,17] Malignant adrenal gland lesions were initially considered to be a contraindication for laparoscopic excision but studies have suggested that adrenal lesions upto 14 cm without local invasion can be removed laparoscopically.[7] Based on several studies, Grumbach et al.[1] concluded that adrenal lesions more than 6 cm should be considered malignant unless proven otherwise. Adrenal surgeries can be performed, either by the conventional open method or by minimally invasive (laparoscopic) technique. Since it's introduction in 1992 by Gagner, laparoscopic adrenalectomy has become the gold standard.[8,19] Now, open surgery is only reserved for invasive and large adrenal masses. Prior to 1980 all adrenalectomies were performed by trans- abdominal open approach. The benefits of laparoscopic approach are decreased hospital stay, faster recovery time, improved patient satisfaction and better cosmetic results. It has also significantly lowered the mortality and morbidity associated with the open procedure due to reduced intra and post operative haemorrhage.[9] The laparoscopic adrenalectomy can be performed using either transperitoneal or the retroperitoneal approach. Laparoscopic transperitoneal adrenalectomy can be performed with patient in either supine or contralateral lateral decubitus positions. Retroperitoneoscopic adrenalectomy can be performed in either prone or lateral positions. The transperitoneal approach has an easier learning curve as the surgeon has more working space and hence suitable for large tumours(>6 cm) as well as obese patients. However in this approach mobilisation of other organs is required thereby increasing chances of injury. Also it involves longer duration of the surgery and increased risk of incisional hernias. Since its inception in 1995 by Miyake

et al, posterior retroperitoneal adrenalectomy (PRA) has been utilised frequently.[10] This technique directly approaches the adrenal gland through the retroperitoneal space, without breaching the peritoneum thereby resulting in a shorter operative time, less blood loss, less postoperative pain, and shorter hospital stay. Disadvantages of this technique are long and arduous learning curve, unsuitability for large tumors and obese patients due to limited working space.[11] Retroperitoneoscopic adrenalectomy in prone position has the added benefit in bilateral adrenalectomy cases of not having to change patient position intraoperatively. Robotic adrenalectomy was first performed in the year 2000 by Horgan and Vanuno. The surgical procedure of robotic adrenalectomy is similar to the laparoscopic approach, such as the patient position, port sites, CO2 insufflation for creating pneumo -peritoneum and specimen retrieval. Robotic surgery is now considered as a standard surgical method for adrenal lesions since it is safe, feasible and an effective technique. It also provides a three dimensional perception, with precise camera control and improved moving capacity of the robotic arms.[12] Needlescopic adrenalectomy- Laparoscopic adrenalectomy with needlescopic instruments (2mm in size) can be performed in most patients with adrenal lesions less than 5 cm. Pheochromocytomas can also be managed but with a longer operative time.[13]

CONCLUSION

Laparoscopic adrenalectomy is now considered the gold standard for treatment of most adrenal gland pathologies. This is because it's magnified view provides better visualization of this deeply situated gland thereby facilitating improved precise dissection and reducing the morbidity and mortality associated with the open surgery. Apart from the conventional advantages, this technique has significantly reduced the incidence of intra and post-operative complications, wound complications, incisional hernias and respiratory problems.

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