Novel Techniques in Laparoscopic Endocrine Surgery

52

Mauricio Sierra, Jorge Montalvo

OBJECTIVE

After its introduction in the early nineties, laparoscopic surgery has consolidated itself as a safe and useful tool with all the known additional advantages of minimally invasive procedures. Regarding endocrine abdominal surgery, dramatic changes have occurred using laparoscopy in the management of complicated diseases, specially in organs which traditionally required very invasive procedures. Such is the case of surgery for neoplasms of the adrenal gland and endocrine tumors originating in the pancreatic gland.

MINIMALLY INVASIVE SURGERY OF ADRENAL GLANDS

Laparoscopic Lateral Transabdominal Adrenalectomy

Introduction

The surgical management of adrenal neoplasms has evolved dramatically in the last 20 years. After laparoscopic adrenalectomy was first described in 1992 by Gagner - like many other novel laparoscopic procedures it is today considered the gold standard of care for small, benign secreting adrenal lesions.

Standard preparation for patients with pheochromocytoma is required for two to three weeks before the operation, using initially an alpha blocker with a Beta blocker if the patient has or develops tachycardia during preparation (but not before hypertension is controlled by alpha blockage); with chrystaloid volume infusion night before and during the operation. In the presence of a non-functional adrenal incidentaloma, a recent imaging study is desirable the week before the intervention to rule out malignancy.

Technique

Under general anesthesia, gastric decompression may be used along with a central venous and arterial line in patients with severe hypertension or cardiac dysfunction. We prefer the patient placed in total lateral decubitus position with latero-forced flexion. (Figure 1) This position increases the working space between the costal margin and the iliac crest, and aides gravity retraction of the adjacent organs related to the adrenal gland. The gland to be resected is always anterior relative to the operating table. To prevent neurovascular injury, all pressure points should be padded and guarded. The leg closer to the operating table is flexed, while the upper leg remains stretched or straight with padding under the knee articulation.

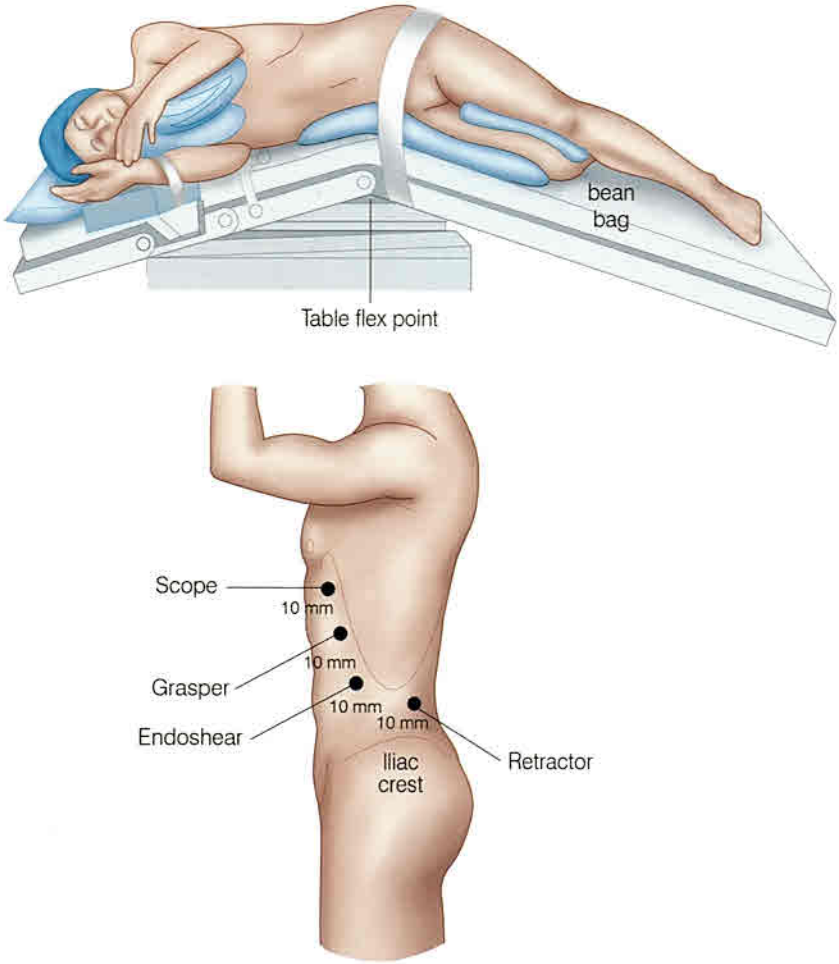

Figure 1. Patient's position to lateral transabdominal left-sided adrenalectomy. From: Michel Gagner, MD. Chapter 38. Endocrine Surgery. Arthur Schwartz.

Placement of ports

A 10 mm incision is made under the costal margin on the anterior axillary or medio-clavicular line as preferred. We instill pneumoperitoneum using the Veress needle with CO2 pressures of 12 to 15 mmHg. A 5 or 10 mm 30° endoscope introduced for cavity exploration. Port location follow the subcostal margin. Whilst the left adrenal can be dissected and operated with three ports (one 5 mm medial, and two 11 mm lateral), the right requires always a fourth medial port inserted under the xyphoid for liver retraction. (Figure 2)

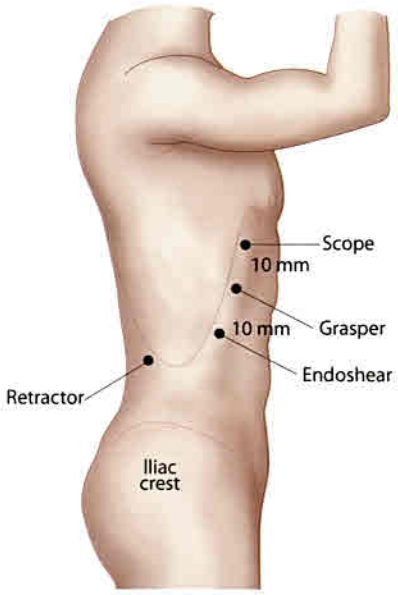

Figure 2. Placement of ports in a right-sided adrenalectomy. Liver retractor through the medial port. From: Quan-Yang Duh, MD. Chapter 33. Endocrine Surgery. Johnathan GH Hubbard.

Right adrenal gland

The triangular ligament of the liver is sectioned with electrocautery or advanced energy. The peritoneum covering the adrenal gland over the superior pole of

the kidney is equally sectioned in a medial fashion with care not to lacerate the adrenal vein. Alternatively, section of this tissue can be initiated from the renal hilum upwards, retracting the vena cava medially and sectioning the arterial irrigation to the adrenal gland with advanced energy on the anterior face of the kidney. The muscle plane should appear after sectioning these latter vessels. The adrenal vein will appear in the uppermost angle under the inferior border of the liver. This vessel should be dissected and ligated with clips trying to leave an adequate stump and no retraction on the vena cava for a tear is difficult to control and should prompt conversion if experience in this operation is limited. The adrenal gland should remain on the lateral aspect of the plane of dissection. On the superior aspect of the gland, an accessory adrenal vein can appear and thus careful dissection is mandatory while liberating the upper pole of the gland from the liver. Once the vascular structures are controlled, the Gerota can be sectioned and the peri-adrenal fat and gland liberated from the upper pole of the kidney with electrosurgery or advanced energy. The gland is extracted always using a bag through one of the larger ports. Drains are rarely used, fascia and skin are closed in the preferred fashion.

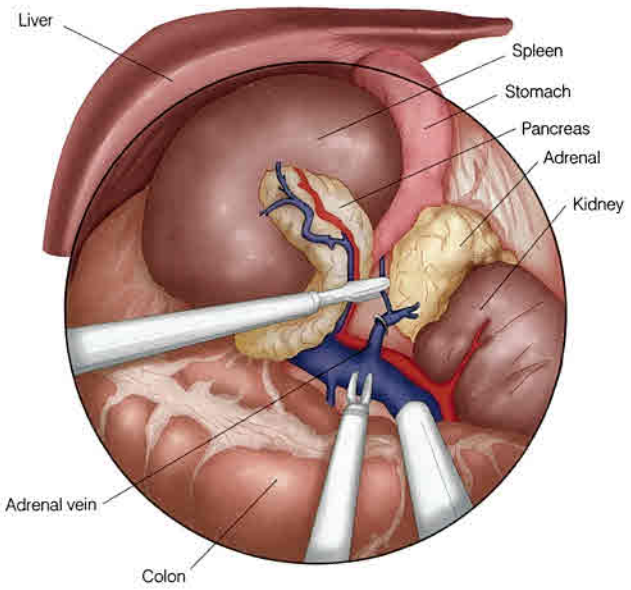

Figure 3. In the left-sided adrenalectomy is important mobilize the splenic flexure of the colon, spleen and tail of pancreas to expose the left adrenal gland. From: Sansiana Roman, MD. Chapter 34. Adrenal Glands. Dimitrios Linos and John A. Van Heerden.

Left Adrenal Gland

After pneumoperitoneum instillation, an optic 11 mm port is placed in the anterior axillary line, with a 5 mm medial port and another 11 mm lateral port. We start by sectioning and mobilizing inferiorly the splenic flexure of the colon using electrocautery or ultrasonic energy. The spleen is mobilized medially by sectioning the esplenorenal and posterolateral ligaments. Gravity pulls and displaces the spleen and tail of the pancreas with its vessels that should be visualized on the left of the screen. (Figure 3) This liberation should continue cephalic until the gastric fundus is exposed with care not to lacerate the diaphragm. The diaphragmatic vein is exposed and followed downwards with the same instrument, opening the muscular plane medial to the adrenal gland where the arterial irrigation is dealt with. It is in this plane that the diaphragmatic vein can be followed to find the adrenal vein, although this latter is not always evident, specially with larger lesions. A fourth port can be inserted laterally to retract on the adrenal gland to facilitate the adrenal vein dissection. When feasible, we prefer to respect the diaphragmatic vein, without any grave consequence if this cannot be achieved. The left adrenal vein is smaller and thus amenable to section with advanced energy. The resection is completed after liberating the gland from the upper pole of the kidney with some of the peri-renal fat. The gland is extracted. Drains are rarely required.

It has been suggested that pheochromocytoma has specific surgical considerations. Recommendations include early control of the adrenal vein and gentle manipulation of the tumor. With larger lesions, and specially on the right side, this maneuver is not always possible, and alternatively arterial irrigation can be initially controlled liberating the gland in a cephalic fashion until the adrenal vein can be dissected and ligated accordingly.

RESULTS

After its introduction, results of this technique were more superior than the open approach. Therefore, today is considered as the gold standard for the treatment of benign and secretory lesions of the adrenal gland. Resections of tumors of up to 18cm have been reported using this approach. Controversy exists on resection of large lesions, documented malignant le-

sions or metastasis to the adrenal gland to have been resected.

The Advantages of conventional laparoscopic adrenalectomy are reflected in the reduction of operation time, morbidity and hospital stay, as well as better recovery from surgery before returning to normal activities when compared with open surgery. Conversion to hand-assisted or open approach may occur in <10% of the cases.

TIPS

Laparoscopic lateral transabdominal adrenalectomy
The surgical technique should be individualized to the patient and the lesion to be resected. Thus, a larger lesion requires sometimes to modify the order of how the vascularity should be attacked, and so the vein may be the last element to be dissected. Meticulous dissection is paramount, leaving an adequate stump without excessive traction on the inferior vena cava (right-sided).

Vascular accidents can usually be controlled with compression and suture if the operator has enough experience to deal with the blood loss while repairing the laceration. On the contrary, when experience is limited, conversion should occur early to prevent important blood loss from this large vein.

Pheochromocytomas are usually heavily vascularized and patience is mainstay to be able to complete resection and blood pressure control during the procedure.

Adrenal glands must be resected integrally for the risk of incomplete tissue resection, carcinomatosis and/or recurrence has been described.

LAPAROSCOPIC / ROBOTIC POSTERIOR RETROPERITONEAL ADRENALECTOMY

Introduction

Whilst the laparoscopic lateral trans-abdominal approach is the easiest to learn and teach, and thus the most practiced; the posterior retroperitoneal approach has regained popularity in the last 10 years, sometimes enhanced by using robotics. Posterior laparoscopic approach was first described in 1995 by Mercan et al. and regained popularity after the experience and excellent results of Martin Waltz were published.

Subsequently, several groups have embraced this approach and even substituted the lateral trans-abdominal approach for this latter intervention.

Albeit still expensive, the robotic system offers three-dimensional optics, excellent resolution, and an ergonomically designed robot station. The da-Vinci robot system is the only FDA-approved robotic surgical system for laparoscopic procedures. The first robotic posterior retroperitoneal adrenalectomy was reported in 2010 by Berber and Cols.

The posterior approach offers the time saving advantage of not needing to turn the patient for contralateral adrenal resection. Additionally, the need for mobilizing abdominal organs such as liver, pancreas and spleen, or lysis of intra-abdominal adhesions to expose the adrenal gland is obviated and thus the relative risk of serious injury. Another benefit of the posterior approach is improved hemostasis due to increased insufflation pressure in the limited retroperitoneal space, less postoperative pain and lower risk of postoperative incisional hernia.

Definition

Minimally invasive posterior retroperitoneal adrenalectomy (laparoscopic or robotic) is performed without the necessity to enter the abdominal cavity and without the need of a third assistant, using only three ports.

Indications

Laparoscopic Posterior Retroperitoneoscopic Adrenalectomy

This laparoscopic posterior approach is ideally indicated for tumors of up to 6 cm, bilateral tumors, and history of upper abdominal operations. They include functional or non-functional primary tumors and secondary lesions (metastasis).

Robotic Posterior Retroperitoneoscopic Adrenalectomy

Indications of this novel robotic posterior approach remain the same as laparoscopic retroperitoneal procedures. However, surgeons with experience with robotic adrenalectomy have suggested there is a subgroup patients with larger tumors that may benefit from the advantages of this approach.

Technique

Laparoscopic Posterior Retroperitoneoscopic Adrenalectomy

Under general anesthesia, a nasogastric tube may be installed to decompress the stomach. A central venous catheter and arterial line are placed routinely in patients with severe arterial hypertension or moderate to severe cardiac dysfunction.

Patient is placed in prone, half-jackknife position. He is then fixed with the knees and hip joints bent at 90°, with gel cushions under the rib cage and pelvis. (Figure 4) This creates sufficient space between the ribs and the posterior iliac crests to insert the ports, allowing for adequate instrument maneuverability. (Figure 5)

Placement of ports. First, a transverse 2 cm incision is made exactly bellow the tip of the 12th rib. (Figure 6) After opening the anterior-most fascia and blunt dissecting the retroperitoneal space around this position with the index finger, a medial para-vertebral 10 mm port is placed in an oblique fashion under the last rib controlling its entrance with the index finger inserted through the optic port incision. A third working port is placed lateral to the optic port perpendicular to the skin, under the 11th rib, controlling its entrance in a similar fashion. Last, a 10 or 12 mm port with an inflatable balloon for the optic port is finally inserted to start the operation. (Figure 7) CO2 instillation is started and maintained with pressures of at least 20 mmHg to create adequate operating space. We recommend a 30 degree endoscope, with the position of endoscope depending of preference of the surgeon. (Figure 8)

Figure 4. Patient's position for Posterior Laparoscopic Retroperitoneal Adrenalectomy. From: Mauricio Sierra, MD.

Figure 5. Anatomy of these structures guides subsequent trocar placement. From: Mauricio Sierra, MD

Figure 6. Transverse incision of 2cm is made exactly bellow the tip of the 12th rib. From: Mauricio Sierra, MD.

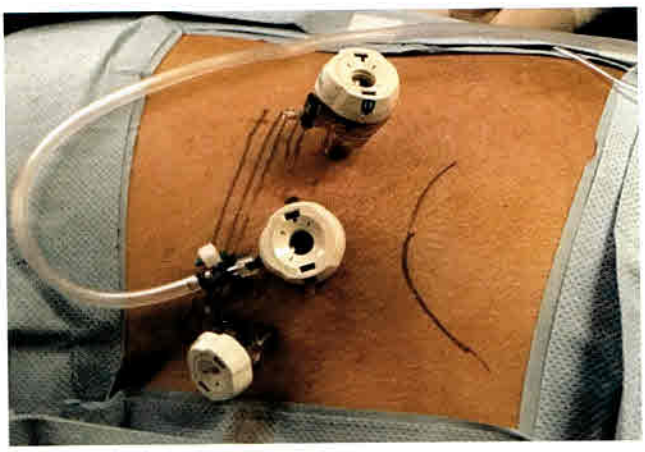

Figure 7. Placement of ports in posterior laparoscopic adrenalectomy, left-sided. From: Mauricio Sierra, MD.

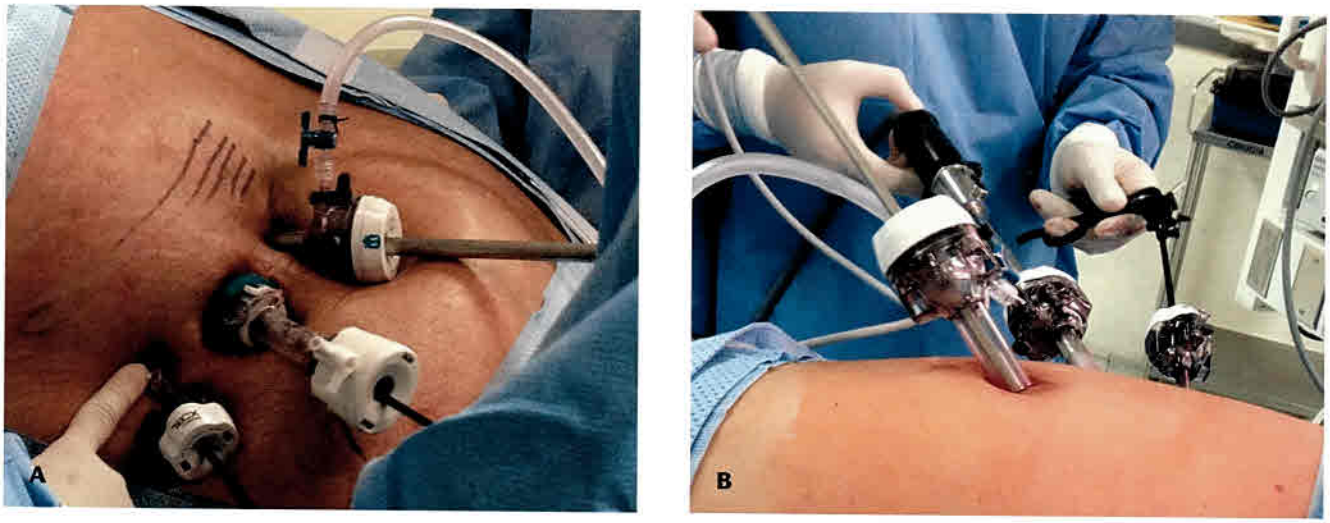

Figure 8. Position of 30° endoscope depends of preference of the surgeon. We recommend use it via medial (A) and middle (B) port. From: Mauricio Sierra, MD.

Periadrenal tissue dissection. The fascia of Gerota is incised transversely at its most cranial aspect exposing the kidney. Retroperitoneal fatty tissue with the adrenal arteries are dissected with harmonic scalpel or advanced bipolar energy in a cephalic fashion, medial and lateral to this latter organ. When this maneuver is achieved correctly, the adrenal gland will be retracted superiorly, with the upper pole of the kidney exposed. (Figure 9) Liberation of the gland in this fashion with the diaphragm as superior limit will expose the adrenal vein medial to the abdominal peritoneum for ligation or section with advanced energy devices or clips as described below. The gland will remain suspended after ligation of the adrenal vein, ready for extraction after dissecting it from the posterior abdominal wall and diaphragm. Patients with hypercortisolism present a special challenge, as a large amount of fatty tissue in retroperitoneal space complicates the dissection of the aforementioned structures.

Adrenal vessel dissection. On the right side, the adrenal gland arteries cross the vena cava posteriorly. They can be separated by Harmonic scalpel, electrocoagulation or clip application. The inferior vena cava is easily identified on the left of the surgical field by liberating or lifting up the adrenal gland and dissecting the fibro-fatty tissue surrounding this vascular structure, medial to the muscle plane. (Figure 10)

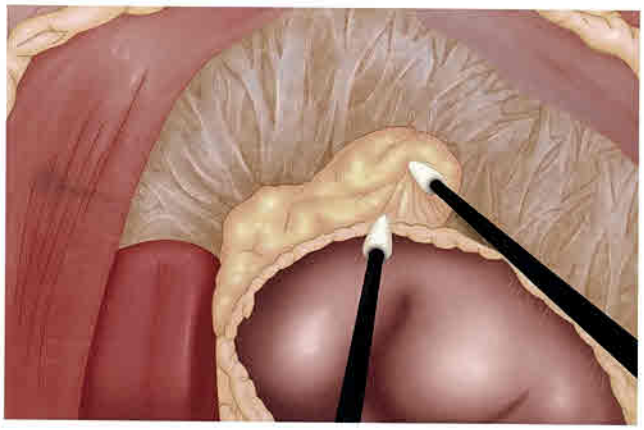

Figure 9. Posterior retroperitoneal adrenalectomy, right side. The adrenal is mobilized upward away from the kidney. From: Nancy D. Perrier, MD. Advances in Surgery 2009;43:147-157.

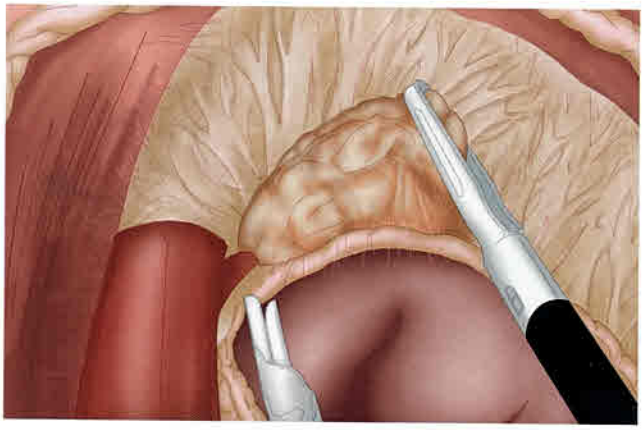

Figure 10. Posterior retroperitoneal adrenalectomy, right side. Adrenal Vein in the medial border of the adrenal gland and drain into the inferior vena cava. From: Nancy D. Perrier, MD. Advances in Surgery 2009;43:147-157.

The right adrenal vein is typically shorter than the left, with a length of 1 cm or less on average. This vein is easily found it running posterior and laterally from the vena cava, immediately inferior to the diaphragm. On the left side, the adrenal vein is found medial to the upper pole of the kidney next to the medial border of the adrenal gland. (Figure 11) Whilst the left adrenal vein can be sectioned with ultrasonic energy because of its size and relation to the renal and diaphragmatic vein; (Figure 12) we recommend clips for the ligation and section of this vessel.

The adrenal gland is removed through the middle incision inside a retrieval bag. Accordingly, the incision site can be enlarged to facilitate extraction. We do not recommend routine use of drains in the retroperitoneal space. Fascia and skin are closed with absorbable suture material.

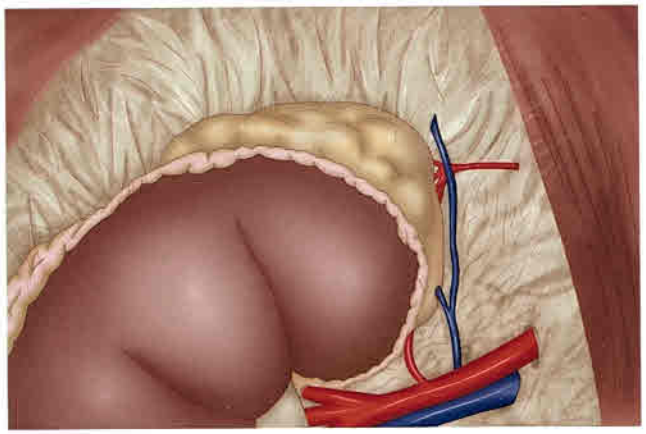

Figure 11. Vascular anatomy of the left adrenal gland. The adrenal vein drains into the renal vein. From: Nancy D. Perrier, MD. Advances in Surgery 2009;43:147-157.

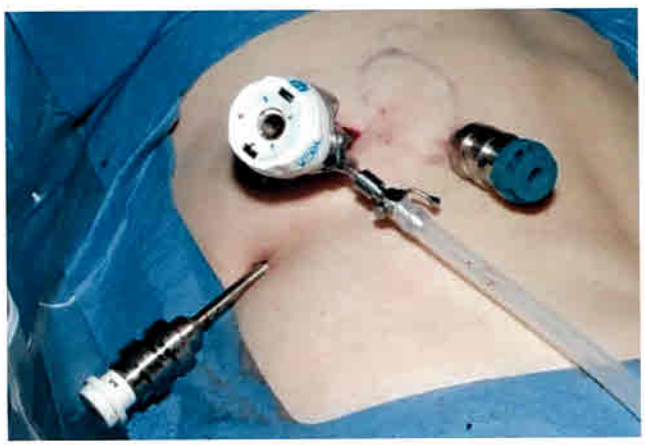

Figure 13. Placement of ports in robotic posterior adrenalectomy, left-sided. The working ports as far away as possible from the camera port. From: Eren Berber, MD. Arch Surg 2010;145:781-4.

Robotic Retroperitoneoscopic Adrenalectomy

Similar to the laparoscopic posterior approach, port position is paramount, as the robot arms need as much space as possible to make the intervention efficient. (Figure 13) The robot is docked in the head of the operating table and port installation is performed in a similar fashion as the conventional technique described above. It is important however, to place both working ports (5mm) as distant as possible from the optic port (12mm) for its dimensions that are larger than the conventional ones. (Figure 14)

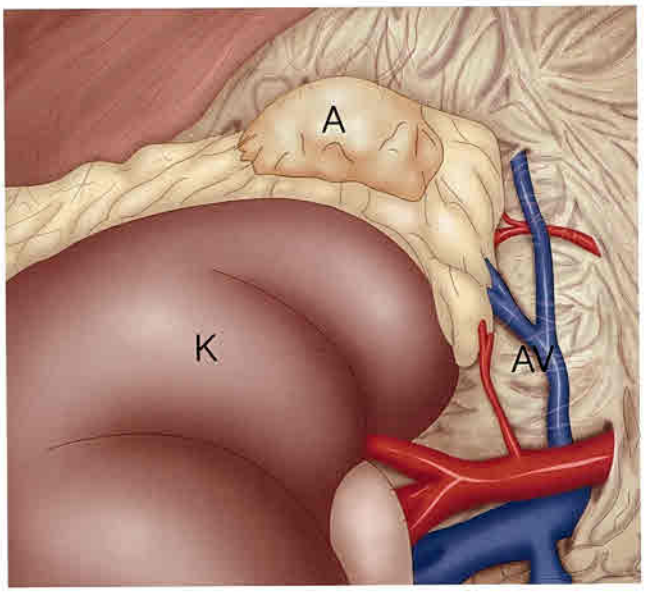

Figure 12. Posterior retroperitoneal view of the left adrenal. The adrenal vein joining the diaphragmatic vein. From: Martin K. Walz, MD. Chapter 35. Adrenal Glands. Dimitrios Linos and John A. Van Heerden.

Figure 14. Robotic system in retroperitoneal adrenalectomy, left-sided. From: Eren Berber, MD. Arch Surg 2010;145:781-4.

High insufflating pressure is used, and laparoscopic ultrasound to locate the affected gland in the retroperitoneal space and surrounded structures is routinely used by someones. The robotic grasper and robotic Harmonic scalpel are the preferred instruments, and almost always used throughout the intervention.

The same principles of dissection and liberation of the gland apply for the robot assisted procedure. Finding the Gerota early in the operation, liberating the gland from the renal capsule laterally and medially until the superior pole of the kidney is exposed. This will facilitate exposure of the adrenal vessels on either side, which can be sectioned with ultrasonic energy. (Figure 15) On occasions, the harmonic scalpel can be exchanged for a clip applier if the vein diameter has a considerable size. Changing instruments is, however, time consuming. After section of the adrenal vein, the gland is liberated from the diaphragm and posterior abdominal wall. The robot is undocked and the adrenal specimen removed through the larger incision using an extraction bag.

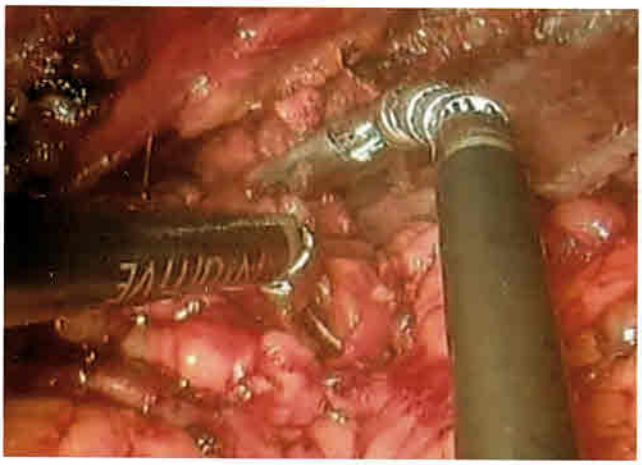

Figure 15. Adrenal gland left-sided. Ergonomic robotic grasper and harmonic scalpel to dissect the adrenal vein which drains into the renal vein. From: Eren Berber, MD. Ann Surg Oncol 2012;19:2288-2294.

RESULTS

Laparoscopic Posterior Retroperitoneoscopic Adrenalectomy

Whilst systematic reviews and meta-analysis evaluate almost always results of retrospective studies when comparing posterior retroperitoneoscopic versus laparoscopic trans-abdominal adrenalectomy, they have described a shorter hospital stay for patients operated by the posterior retroperitoneoscopic approach. ($p = 0.001$) This reduction in hospital stay was associated to less postoperative pain (no opening the peritoneum or manipulation of the abdominal viscera), more significant in centers where endocrine surgeons operated these patients. The conversion rate for the posterior retroperitoneoscopic adrenalectomy is accepted to be 5 to 10 %. Indications for conversion was bleeding, failure to progress in dissection, reduced operative field, and repeated loss of pneumo-retroperitoneum. Postoperative complications described were pneumothorax, haemothorax, subcutaneous emphysema, pneumonia, wound infection and neuralgia. No observed statistical differences were found regarding conversion, postoperative complications, duration of surgery and blood loss.

Robotic Retroperitoneal Adrenalectomy

Amidst a longer preoperative routine, the robotic posterior approach can achieve equal operative times compared to those of trans-abdominal laparoscopic and open approaches.

The learning curve of robotic retroperitoneal adrenalectomy has been described to be from 10 to 20 procedures; faster if surgeons are already familiarized with robotic procedures or laparoscopic posterior approach. Experience with conventional adrenalectomy is preferable and mainstay for adequate practice with the robotic approach.

Comparative results between robotic and laparoscopic posterior adrenalectomy have equally been described. However, Agcaoglu demonstrated a significant improvement in skin-to-skin operative time after the 10th procedure, lowering operating times from 209.6 to 139.1 minutes on average. This improvement reach significant difference when they compared this subgroup with laparoscopic posterior approach ($p = 0.046$).

TIPS

Careful patient selection is key to the successful resection of adrenal tumors, with tumor size and position being the major determinants of feasibility. Adrenal tumor size of less than 7 cm and located above the renal vessels are appropriate to posterior resection.

Ports placement is paramount, more so in the robotic approach, where the arms of the robot need more space to move in the operating field. Working ports should be placed as distant as possible from the optic port. High insufflating pressures (20 to 30 mmHg) are always required to provide adequate operating space to facilitate dissection.

Whilst no invasion or abdominal organ liberation is required, no anatomical structures aside of the kidney can help identify the adrenal gland and thus facilitate its resection. The retroperitoneal space is somewhat strange for the general surgeon, and patience is required to complete the operation when taking on this approach. This is specially important in cases of hypercortisolism, where retroperitoneal fat increases in volume and density.

Laparoendoscopic Single-Site (LESS) Adrenalectomy

The search for new and less invasive procedures has resulted in development of N.O.T.E.S. and Laparoendoscopic Single Site Surgery (LESS). While N.O.T.E.S. has yet to live up to the expectations created initially; LESS has demonstrated to be a feasible and reproducible technique. If anything, LESS has profited from the technology derived from N.O.T.E.S. to be able to perform complicated interventions using a single port of access. Advanced optics and special instruments allow for improved vision and triangulation, regardless of the platform used.

Whilst principles of the technique remain the same, the operator will need to work with the instruments crossed, so that the dominant arm will be the left, while the right will serve for retraction. Some platforms allow for a third assisting port.

Left adrenalectomy is the ideal operation for LESS because gravity helps with the retraction of the spleen and pancreas, and the adrenal vein and gland can be dissected in the same fashion as in the lateral approach. (Figure 16) The right adrenal gland requires an additional port for liver retraction, and experience to deal with the medial part of the vena cava and adrenal vein.

Hirano et al. reported the first laparoscopic adrenalectomy by single port incision in 2005. Experience is mandatory when entailing LESS for the adrenal gland.

Only small series of LESS for adrenal lesions have been published. We know from these latter that it is equally effective and advantageous cosmetically (mean cosmetic satisfaction score 9.5 vs 9.1), but with longer mean operating times (148.5 vs 112. minutes).

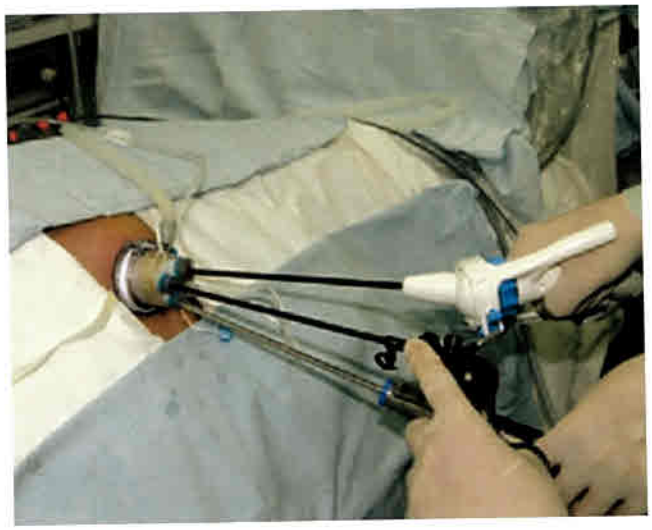

Figure 16. Posterior LESS adrenalectomy left-sided, umbilical incision. From: Linhui Wang. Urology 2012;79:577-583.

MINIMALLY INVASIVE SURGERY OF THE PANCREAS

Introduction

Neuroendocrine tumors (NET) of the pancreas arise from the islet cells of Langerhans. Accordingly, they are classified after the functional syndrome that they produce (peptide and hormone release) or as non-functioning tumors. Multiple tumors and early onset usually arise in the context of hereditary syndromes such as Multiple Endocrine Neoplasia 1 syndrome (MEN 1).

Functional tumors can produce insulin, gastrin, glucagon or vasoactive intestinal peptide (VIPomas). Contrary to the clinical presentation and behavior of gastrinomas, glucagonomas or VIPomas (multiple, aggressive and with advanced disease at diagnosis); pancreatic insulinoma is the most common form of pancreatic NET and has features that make it ideal for laparoscopic resection: sporadic and single (90%), small (< 2 cm) and benign (90%).

Laparoscopic resection of a pancreatic islet cell tumor was first described in 1996 by Gagner. Considered prohibitive because of its anatomical situation and high complication rate, pancreatic laparoscopic surgery was not immediately accepted until recently. Today, laparoscopic resection of the distal pancreas and tumor enucleation are the most common surgi-

cal procedures performed in centers with experience and have gained world-wide acceptance.

Minimally invasive pancreatic surgery is feasible only when localization studies are able to identify the lesion. If available, laparoscopic ultrasound can be used to confirm radiology findings. When the latter are negative, we recommend an open procedure with manual exploration with or without conventional ultrasound. Blind distal pancreatectomy is contraindicated in the event of a false positive localization study. The operation should be converted to perform a formal open exploration.

Laparoscopic enucleation for insulinomas is recommended when located in the parenchyma of the pancreatic head or body. Improvements in minimally invasive techniques have made novel approaches possible for resection of insulinomas. Such is the case for laparoendoscopic single site surgery (LESS), and robotic surgery. Low incidence of pancreatic surgical pathology accounts for the small series evaluating the results of laparoscopic surgery in this gland.

Definition

Laparoscopic distal pancreatectomy consists of resection of the body and tail of the pancreas, with or without spleen preservation. Enucleation is reserved for tumors in the head and body carefully avoiding lesion to the main pancreatic duct.

Incidence

The overall prevalence of functional pancreatic neuroendocrine tumors is low (1 to 10 per million in the population). Although insulinoma is the most common functional pancreatic NET, it only occurs in 1 - 4 per million population. There is a well known difference on incidence according to ethnicity. Thus, they are higher in African-Americans (6.5 per 100,000 per year compared to 4.4 x 100,000 per year in Caucasians).

Indications

Surgery is the only potentially curative treatment currently available for resectable pancreatic NETs. Indications for surgery include systemic symptoms due to hormone release. Rarely, patients present with local compressive symptoms, suggestive of advanced disease or malignant transformation. Palliative surgery can sometimes be performed laparoscopically. As aforementioned, insulinoma, out of all functional pancreatic NETs is amenable to pancreatic laparoscopic resection, along with small non-functional pancreatic NETs. It is typically contraindicated for patients with other functional pancreatic tumors and MEN1 syndrome patients where multiple lesions are characteristic or require open exploration and sometimes radical pancreatic gland resections. Whilst Pancreatoduodenectomy (Whipple procedure) is not routinely performed, it has been deemed feasible even in the presence of advanced invasive disease.

Laparoscopic Technique

Laparoscopic Distal Pancreatectomy (LDP)

These approach entails the resection of the body and tail of the pancreas. Variants include spleen resection, spleen preservation with resection of the retropancreatic splenic vessels, or spleen preservation and splenic vessels. Spleen preservation frequently leads to thrombosis of the splenic vein and need of reoperation; and is only performed in experienced centers.

Under general anesthesia, a gastric tube may be placed for gastric decompression. Parenteral antibiotics are preoperatively administered. The patient is placed in modified supine position, with the legs on spreader bars and with the left side rolled up about 20°. We use the Veress needle for pneumoperitoneum instillation at 15-mmHg through the the umbilicus.

Port placement

We recommend a 30 degree endoscope. The abdominal cavity is explored looking for peritoneal or liver metastasis. Two para-rectal working ports are introduced, a left subcostal for the assistant. (Figure 17) One additional port under the xyphoid can be used to retract the stomach and liver.

The gastrocolic ligament is sectioned just under below the gastroepiploic arcade. This is divided using advanced energy (ultrasonic dissector, advanced bipolar) The stomach is retracted cephalic and the anterior surface of the body of the pancreas is exposed. After dissection of congenital loose adhesions, laparoscopic ultrasound may be used to confirm localization of the lesion and its relationship with the

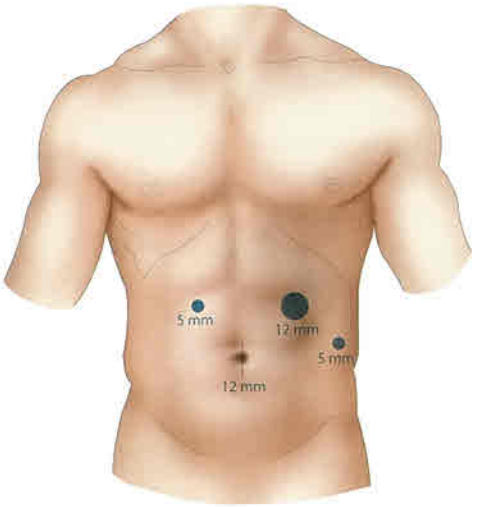

Figure 17. Placement of ports in distal laparoscopic pancreatectomy. From: Yoshiharu Nakamura, MD. J Nippon Med Sch 2010;77:106-110.

main pancreatic duct. When the tumor is located in the neck of the pancreas, it is advisable to divide the right gastroepiploic vessels to maximize exposition.

The posterior peritoneum over the inferior border of the pancreas is divided from right to left direction. The splenic vein is identified inferior and behind of the pancreas. Small pancreatic vessels arising from the splenic vein toward the posterior surface of the pancreas should be divided between clips or ultrasonic energy to try to preserve the spleen. The tail of the pancreas is then dissected and separated from the splenic hilum posterior along the gland. The splenic artery is identified at level the superior border of the pancreas which can present a spiral course, and care should be taken to avoid laceration. This latter is separated of the distal pancreatic parenchyma using ultrasonic energy. (Figure 18) The distal pancreas is liberated and elevated from the tail towards the body of the pancreas for an adequate zone of transection with a linear endoscopic stapler. (Figure 19)

It may occur that the splenic vein separation may require resection with the specimen using and endoscopic vascular stapler or intracorporeal knot.

If distal pancreatectomy with splenectomy is contemplated, the spleen is mobilized medially dividing the lienophrenic, splenorenal and lienocolic ligaments using ultrasonic energy after dissection of the body and tail of the pancreas, and when possible, ligation of the splenic artery. Splenic vessels (vein and artery) are then resected with the specimen. This latter case is performed in the majority of distal pancreatectomies, regardless of the experience of the surgeon or center.

Finally, pancreatic transection is marked medially, 1 cm proximal from the pancreatic tumor. An endoscopic stapler with vascular load is fired across the body of the pancreas. The surgical specimen is extracted with the help of a retrieval bag. Irrigation

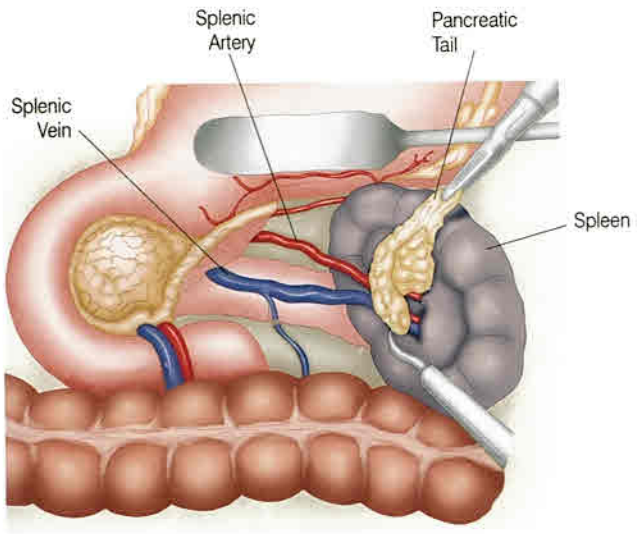

Figure 18. Medial-to-distal technique, preserving splenic vessesl behind of the resected pancreatic parenquima. From: John E. Cameron, MD. ACS:Principles and practice 2006. Chapter 24.

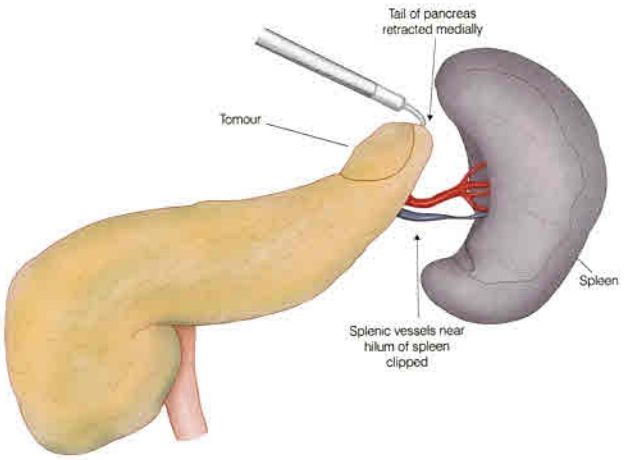

Figure 19. Lateral-to-medial technique for distal laparoscopic pancreatectomy. From: Ho Choon Kiat, MD. ANZJSurg 2009;79:288-293.

and suction of the surgical field is performed. Fibrin glue can be applied over the pancreatic stump with or without reinforcement of the staple line with 2-0 non-absorbable suture. We consider insertion of a drain mandatory and retired only after the patient has re-established formal diet; usually 7 days after the operation. The fascia and skin are closed with the material of preference.

Laparoscopic Enucleation

Preoperative preparation for enucleation is identical as for its resective counterpart. Position of the patient and port placement follow the same principles as to optimize exposition to the whole pancreatic gland. The gastro-colic ligament is sectioned and laparoscopic ultrasound may be used to confirm position of the lesion. The ideal tumor is the one situated on the anterior aspect of the gland, distal to any vascular structure or main pancreatic duct. (Figure 20) This latter aspect should be carefully evaluated. Morbidity from this complication extends intra-hospital stay and consumes an important amount of resources. If at risk, open pancreatoduodenectomy should be considered by experienced hands.

We perform pancreatic enucleation incising through the pancreatic parenchyma around the edge of the tumor using Harmonic scalpel. If bleeding occurs, compression can be applied, and if necessary, 5 or 10 mm. clips can be applied over the tumor bed, with care for the aforementioned structures.

The tumor specimen is removed inside a retrieval sterile bag through the 12-mm port. A closed drain is placed, following the exact same principles as described for the distal resection.

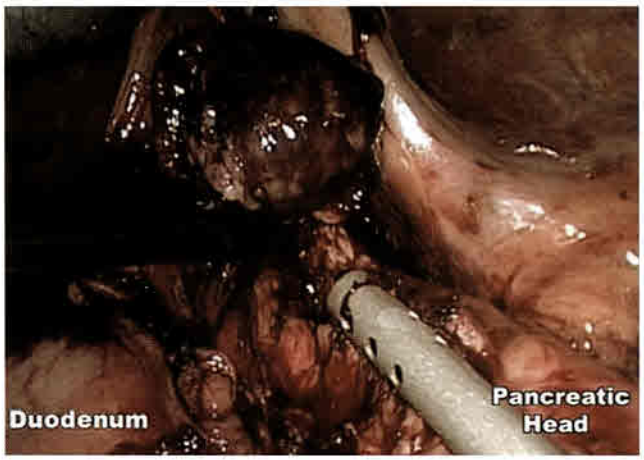

Figure 20. Enucleation of NET on the pancreatic head. (NET, neuroendocrine tumor). From: Laureano Fernández-Cruz, MD. HPB 2012;14:171-176.

RESULTS

Laparoscopic approaches for pancreatic lesions are equally effective from the resection and cure point of view, with the added advantages of the minimally invasive surgery (less postoperative pain, shorter hospital stay and faster recovery times) and less morbidity. In the laparoscopic approach, magnification allows more precision on tumor dissection which can in turn explain the higher success rate of splenic preservation described in some comparative studies that evaluate the open versus the laparoscopic approach. However, it has been described an association of laparoscopic distal pancreatectomy and a higher rate of late post-discharge readmission. Additionally, studies have showed that the number of lymph nodes resected during laparoscopic distal pancreatectomy is significantly lower than that of the open approach. In experienced hands, and in the context of sporadic and well localized tumors, cure rates approach almost 100% of cases, using any of the minimal invasive approaches.

Fistula remains the main and most feared complication after pancreatic surgery (enucleation or distal pancreatectomy). This can occur in up to 20% of cases, similar or lightly higher than the open surgical procedures. Pancreatic enucleation has the higher risk of fistula occurrence compared to distal pancreatectomy. In the context of hereditary disease, patients operated had a higher rate of postoperative pancreatic fistula in both enucleation and resection procedures. This can be apparently explained by an abnormal pancreatic parenchyma and the existence of multiple microscopic lesions. Whilst, a laparoscopic approach for these patients is considered controversial, this risk could be reduced by a detailed clinical examination, careful exploration of the pancreatic gland by laparoscopic ultrasound, and pancreatic duct identification during tumor resection.

TIPS

In the context of distal pancreatectomy with splenectomy, it is generally advised to divide the splenic vessels individually with a separate vascular load of

an endoscopic stapler to prevent the occurrence of arteriovenous fistula.

Whilst nothing can replace a careful and meticulous technique to prevent postoperative pancreatic fistula occurrence, fibrin glue and others similar agents have been proposed to be applied on the pancreatic stump or enucleation bed with reinforcement of the staple line with synthetic non-absorbable suture.

Pancreatic fistula can occur anywhere from day one thru seven. Patients may be discharged with the drain and should be retired only when he or she has reestablished a normal diet. In the occurrence of fistula, ambulatory care can be carried out with proper attention and dietetic care through the resolution of this complication.

References

1. Gagner M, Lacroix A, Bolte E. Laparoscopic adrenalectomy in Cushing's syndrome and pheochromocytoma. N Engl J Med 1992;327:1033.
2. Barreca M, Presenti L, Renzi C, Cavallaro G, Borrelli A, Stipa F, Valeri A. Expectations and outcomes and moving from open to laparoscopic adrenalectomy: multivariate analysis. World J Surg 2003;27:223-8.
3. Plaggemars HJ, Targarona EM, van Couwelaar G, D Ambra M, Garcia A, Rebasa P, Rius X, Trias M. What was changed in adrenalectomy? From open surgery to laparoscopy? Cir Esp 2005;77:132-8.
4. Bittner JG, Gershuni VM, Matthews BD, Moley JF, Brunt ML. Surg Endosc 2013;ahead of printed.
5. Mercans S, Seven R, Ozarmagan S, Tezelman S. Endoscopic retroperitoneal adrenalectomy. Surgery 1995;118:1071-5.
6. Walz MK, Peitgen K, Krause U, et al. Dorsal retroperitoneoscopic adrenalectomy: a new surgical technique. Zentralbl Chir 1995;120(1):53-58.
7. Berber E, Mitchell J, Milas M, Siperstein A. Robotic posterior retroperitoneal adrenalectomy: operative technique. Arch Surg 2010;145(8):781-4.
8. Constantinides VA, Christakis I, Touska P and Palazzo FF. Systematic review and meta-analysis of retroperitoneoscopic versus laparoscopic adrenalectomy. Br J Surg 2012;99:1639-1648.
9. Li QY, Li F. Laparoscopic adrenalectomy in pheochromocytoma: retroperitoneal approach versus transperitoneal approach. J Endourol 2010;24:1441-1445.
10. Lee CR, Walz MK, Park S, Park JH, Jeong JS, Lee SH, Kang SW, Jeong JJ, Nam KH, Chung WY, Park CS. A comparative study of the transperitoneal and posterior retroperitoneal approaches for laparoscopic adrenalectomy for adrenal tumors. Ann Surg Oncol 2012;19:2629-2634.
11. Brunaud L, Ayav A, Zarnegar R, et al. Prospective evaluation of 100 robotic-assisted unilateral adrenalectomy: operative technique. Surgery 2008;144(6):995-1001.
12. Morris LF, Perrier ND. Advances in robotic adrenalectomy. Curr Opin Oncol 2012;24:1-6.
13. Agcaoglu O, Aliyev S, Karabulut K, Siperstein A, Berber E. Robotic vs laparoscopic posterior retroperitoneal adrenalectomy. Arch Surg 2012;147(3):272-275.
14. Berber E, Mitchell J, Milas M, Siperstein A. Robotic posterior retroperitoneal adrenalectomy: operative technique. Arch Surg 2010;145(8):781-4.
15. Hirano D, Minei S, Yamaguchi K, et al. Retroperitoneoscopic adrenalectomy for adrenal tumors via a single large port. J Endourol. 2005;19:788-792.
16. Wang L, Liu B, Wu Z, Yang Q, Chen W, Sheng H, Xu Z, Xiao L, Wang C and Sun Y. Comparison of single-surgeon series of transperitoneal laparoendoscopic single-site surgery and standard laparoscopic adrenalectomy. Urology 2012;79:577-583.
17. Ramage JK, Ahmed A, Ardill J, Bax N, Breen DJ, Caplin ME, P Corrie, Davar J, Davies AH, Lewington V, Meyer T, Newell-Price J, Poston G, Reed N, Rockall A, Steward W, Thakker RV, Toubanakis C, Valle J, Verbeke C, Grossman AB. Guidelines for the management of gastroenteropancreatic neuroendocrine (including carcinoid) tumours (NETs). Gut 2012;61:6-32.
18. España-Gómez MN, Velázquez-Fernández D, Bezaury P, Sierra M, Pantoja JP, Herrera MF. Pancreatic insulinoma: a surgical experience. World J Surg 2009;33:1966-1970.
19. Gagner M, Pomp A, Herrera MF. Early experience with laparoscopic resections of islet cell tumors. Surgery 1996;120:1051-1054.
20. Modlin IM, Lye KD, Kidd M. A 5-decade analysis of 13,715 carcinoid tumors. Cancer 2003;97:934-59.
21. Vaidakis D, Karoubalis J, Pappa T, Piaditis G, Zografos GN. Pancreatic insulinomas: current issues and trends. Hepatobiliary Pancreat Dis Int. 2010;9:234-41.
22. Yeo CJ, Wang BH, Anthone GJ, Cameron JL. Surgical experience with pancreatic islet-cell tumors. Arch Surg 1993;128:1142-8.
23. Mehta SS, Doumane G, Mura T, Nocca D, Fabre JM. Laparoscopic versus open distal pancreatectomy: a single-institution case-control study. Surg Endosc 2012;26:402-407.
24. Langer P, Fendrich V, Bartsch DK. Minimally invasive resection of neuroendocrine pancreatic tumors. Chirurg 2009;80:105-112.
25. Kendrick ML and Cusati D. Total laparoscopic pancreaticoduodenectomy: feasibility and outcome in an early experience. Arch Surg 2010;145:19-23.
26. Kendrick ML and Sclabas GM. Mayor venous resection during total laparoscopic pancreaticoduodenectomy. HPB 2012;13:454-458.
27. Nigri GR, Rosman AS, Petrucciani N, Fancellu A, Pisano N, Zorcolo L, Ramacciato G, Melis M. Metaanalysis of trials comparing minimally invasive and open distal pancreatectomies. Surg Endosc 2011;25:1642-1651.