LAPAROSCOPIC ADRENALECTOMY: A NEW STANDARD OF CARE?
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Laparoscopic adrenalectomy (LA) has been performed in humans1,2 since the early 90’s and has now been described in a small number of veterinary patients.3-5 This approach combines the best aspects of both the paracostal and ventral celiotomy approaches. Positioning the animal in lateral or near lateral recumbency provides excellent visualization of the gland and it's surrounding structures without the pain and morbidity associated with the paramedian muscle incision. Unlike the celiotomy approach, extensive retraction and compression of surrounding organs is unnecessary.

Due to the close anatomical relationship of the adrenal gland to large vascular structures and the propensity for these tumors to invade these and other structures adrenalectomy from any approach has always provided surgical challenges. The right adrenal gland can be especially difficult, as the gland capsule is continuous with the tunica externa of the caudal vena cava in dogs, making this dissection more challenging. However, successful right adrenalectomy is also possible from a laparoscopic approach and has been described in small numbers of canine patients.4,5 The most common indication for adrenalectomy in dogs is for removal of primary adrenal neoplasms, most commonly adrenocortical adenomas, adenocarcinomas, and pheochromocytomas.6,7 In cats, functional adrenocortical tumors and aldosterone-secreting tumors occur, but are less common.8-10 Incidentally discovered adrenal masses that do not appear to be functional or associated with clinical signs are increasingly detected during routine imaging studies performed for other reasons.

Diagnostic imaging is an important part of the pre-operative work-up for adrenal masses and forms the basis for decision making as to whether a laparoscopic approach might be feasible. The dimensions of the mass are important, as are the relationships to surrounding organs and vascular structures. Approximately 25% of adrenal neoplasms exhibit vascular invasion into the vena cava, phrenicoadominal veins, or renal vasculature, with pheochromocytomas more likely to invade than adrenocortical tumors.7 If detected pre-operatively, vascular invasion should be considered an indication for an “open” approach at this point in time. Ultrasonography and computed tomography (CT) are most often used for pre-operative imaging. Ultrasonography has been shown to have a sensitivity and specificity of 80 and 90%, respectively, for detection of tumor thrombus.7 Sensitivity and specificity of CT are 92 and 100% respectively.11 In the author’s institution all potential candidates for LA undergo a CT scan if possible to rule out vascular invasion and evaluate the anatomical margins of the tumor.

Case selection for LA is key to success especially in the early part of a surgeon’s learning curve. The author considers animals with functional tumors up to 3-4cm in diameter that do not exhibit vascular invasion to be good cases for LA. Cases with vascular invasion of the mass into surrounding vessels or large masses (>5cm) are probably best treated by open adrenalectomy; however, the effect of tumor size on morbidity during LA has not been evaluated in small animals. Animals that may be poorly tolerant of pneumoperitoneum such as those with severe cardiorespiratory disease or those with diaphragmatic herniation are poor candidates for LA. Inadequate training or lack of the appropriate instrumentation is also an important contraindication for LA as this is an advanced laparoscopic procedure and surgeons attempting it...
should first be proficient with the procedure performed in open fashion as well as having significant experience with other laparoscopic procedures.

**Patient preparation** - Prior to surgery, the same pre-operative management of adrenal neoplasia as would be performed for “open” adrenalectomy should be pursued. In the case of functional adrenocortical tumors administration of trilostane (2.5-5mg/kg BID PO) for 2-3 weeks prior to surgery is performed in the author’s institution. Supplementation with corticosteroids prior to initiation of surgery to avoid a hypoadrenocortical episode in the recovery period is important. Suitable choices include dexamethasone (0.1-0.2mg/kg IV), prednisolone sodium succinate (1-2mg/kg IV) or hydrocortisone (2mg/kg IV). In animals where pheochromocytoma is suspected, pre-treatment with an α-adrenergic blocker, such as phenoxybenzamine (escalating dose up to 1-1.5mg/kg PO), should be considered for several weeks pre-operatively until the animal is normotensive. This drug has been shown to improve outcome in dogs undergoing adrenalectomy.12 In cats with functional adrenocortical tumors, it has been suggested that treatment with trilostane, be initiated until the skin abnormalities, accompanying the condition in this species resolve.10 Cats with aldosterone-secreting tumors should have their metabolic and electrolyte disturbances corrected prior to surgery.

**Patient positioning and port placement** - The author’s preference is to position the patient on the surgical table in lateral or near-lateral position with the affected gland up. The use of a mechanical tilt table is preferable as in some cases tilting the dog one way or the other might help with visualization and retraction. The surgeon and surgical assistant (laparoscope holder) should stand on the side of the table that faces the animals ventral abdomen, with the endoscopic tower placed directly opposite the surgeon on the side facing the animals back. A three or four port technique can be used for LA in dogs depending on how much active retraction is necessary. Initially we established a subumbilical camera portal on the ventral midline but now place the camera portal 2-5cm lateral to the umbilicus on the affected side to improve visualization of the tumor. Instrument ports are placed in a triangulating pattern around the location of the adrenal gland. Instruments should not be placed too close together to avoid interference during dissection. For a left-sided lesion, place a trocar-cannula assembly suitable for passage of 5mm instrumentation 5-10cm cranial to and 5-8cm lateral to the subumbilical port on the left side in a location just caudal to the costal arch. It is important that the port remain caudal to the last rib to avoid inadvertent penetration of the thoracic cavity. Place a second instrument port 5-10cm caudal and 5-8 cm lateral to the subumbilical port in the lower left quadrant. One of these three ports is usually established using a cannula suitable for passage of 10mm instrumentation, which allows passage of a 10mm clip applier (if needed) and specimen retrieval bag. If a right-sided adrenalectomy is being performed, the ports are placed at similar locations but on the opposite side.

**Technique description** – Once abdominal access has been achieved, the peritoneal cavity is explored to evaluate for intercurrent pathology or signs of metastasis. The liver is inspected and biopsied if suspicious lesions are found. Obtaining good visualization of the lesion is the first challenge after port placement. During left-sided LA, the spleen or stomach will often obscure visualization of the cranial pole of the adrenal gland, and the kidney will sometimes obscure visualization of the caudal margin of the gland. On the right side, the right lateral lobe of the liver may affect visualization and might need to be retracted cranially. The kidney can require
retraction dorsally and caudally. Intestines can also intermittently obscure visualization of right or left glands, but will usually fall ventrally once the animal is in lateral recumbency. On the right side, retraction of organs in order to visualize the lesion is usually less necessary than it is on the left side. Several strategies exist for improving visualization. The use of a head-down (trendelenburg) positioning may prevent the stomach and spleen moving caudally, thus aiding in visualization of the cranial aspects, although this can make visualization of the caudal parts of the dissection more difficult. Alternatively, a third (or more) instrument port(s) can be placed more dorsally over the kidney and a retractor used to move structures cranially or caudally during dissection.4

In dogs, at least part of the adrenal gland is usually visible, allowing the surgeon to initiate dissection of the retroperitoneal space close to the gland. In obese animals and in cats, the gland can be completely obscured by fat, in which case dissection through the fat to localize the gland maybe necessary. A vessel-sealing device is necessary to cut and coagulate through the tissue planes around the gland. A blunt probe, babcock forceps or endopeanut is used to aid in manipulation of the gland as the dissection progresses. Intermittent suctioning of small amounts of hemorrhage as well as fat around the gland helps with visualization, and the suction-irrigation tip can be used as an aid to dissection. The adrenal gland receives arterial supply from numerous small arteries and is drained principally by the adrenal vein, which on the right side enters directly into the caudal vena cava and on the left enters the renal vein. Clinically, these smaller vessels are difficult to directly visualize but result in hemorrhage from almost all planes of dissection if a vessel-sealing device or bipolar cautery is not used. The phrenicoabdominal vein and artery are large and must be identified and ligated. Vessel-sealing devices should reliably seal the phrenico-abdominal vessels of small to medium-sized dogs if they are <5-7 mm in diameter. In larger dogs, hemoclips can be placed on these vessels but are now rarely used by the author.

As dissection of the gland progresses, babcock forceps can sometimes be placed on the tissues surrounding the gland to aid in retraction; however, care should be taken to avoid penetration of the capsule. The gland should be handled with blunt instruments to minimize the risk of penetrating the capsule and tumor seeding of the peritoneal cavity.

In order to avoid port site metastases, it is important to place the mass in a specimen retrieval bag prior to removal. The inverted thumb of a large-sized surgical glove can also be used as an inexpensive specimen retrieval device. The surgical site should be thoroughly lavaged with sterile saline and closely inspected for ongoing hemorrhage.

Complications and follow-up - Several important intra-operative complications are possible during laparoscopic adrenalectomy and are mostly similar to those seen with open adrenalectomy. The ability to address complications may be compromised due to the lack of manual access to the surgical field. Dissection close to major vascular structures makes profuse hemorrhage possible. If vascular invasion goes undetected preoperatively, hemorrhage may be more likely to occur, highlighting the importance of preoperative diagnostic imaging. If significant hemorrhage occurs, immediate conversion to an open approach should be performed. If it is possible to suction enough blood to visualize the bleeding vessels, clamping or clip application can be performed. The most common problem is “nuisance” hemorrhage that is not hemodynamically significant but prevents visualization of the surgical field and prolongs surgical time.
Thromboembolism is a potentially fatal complication and has been seen after both open and laparoscopic adrenalectomy in dogs and necessitates careful monitoring. In dogs with functional adrenocortical tumors, monitor for post-operative hypoadrenocorticism. Ongoing therapy with corticosteroids should be continued for 2-3 weeks postoperatively until the results of ACTH stimulation tests confirm normal corticosteroid production from the contralateral adrenal gland.

Experience with LA to date – The argument that LA could become the standard of care for surgical resection of non-invasive adrenal tumors in small animals is a plausible one. In human medicine it is standard of care for both functional cortical tumors as well as pheochromocytomas and tumors up to 9cm will be approached laparoscopically by some surgeons. The author’s group have used the laparoscopic approach on 17 dogs and 3 cats for resection of adrenal masses to date (data from University of Pennsylvania and UC-Davis). All animals have been discharged from the hospital. Of the non-invasive adrenal tumors surgically resected at UC-Davis in the past 2 years approximately 75% were removed laparoscopically (4 dogs had tumors >5cm diameter or associated large hematomas and were operated in traditional open fashion). We therefore believe that LA can be a useful technique for a significant subsection of canine and feline patients requiring adrenalectomy. Other groups have reported excellent success with this technique also. Despite the short-term results being encouraging, the long-term oncologic outcome remains to be proven although in one report no recurrence of clinical signs was reported in a cohort of 7 dogs with functional adrenocortical tumors. For practitioners wishing to perform LA in dogs and cats we would advise that prior experience be sought in a minimally invasive teaching laboratory and that suitable equipment be available to maximize the chance of success and minimize morbidity.

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