Adrenalectomy

Adrenalectomy is the removal of one or both adrenal glands. Hypophysectomy is the removal of the pituitary gland (hypophysis). Hyperadrenocorticism (HAC) is a multisystemic disorder caused by an excess of glucocorticoids. Cushing disease refers to HAC caused by a pituitary adenoma. Addison disease is caused by a deficiency of glucocorticoids or mineralocorticoids or both.

Adrenal glands are small organs with a big role to play. They are responsible for producing hormones like adrenaline and cortisol that are involved in controlling the body's blood pressure, metabolism and response to stress. You can therefore imagine that when one or both of these glands become diseased, a variety of things can start to go wrong in the body. Although adrenal gland tumours in dogs are relatively uncommon, they can cause some very uncomfortable symptoms for our pets such as high blood pressure, anxiety, weight gain, changes in urination and hair loss. If left untreated, these tumours can lead to serious consequences for your pet. Adrenal tumours can arise from different parts of the gland, and can cause a variety of symptoms depending on whether they are secreting hormones, and what hormones they are secreting.

Animals with HAC are at increased risk for postoperative pulmonary thromboembolism (PTE). If hypercoagulability is suspected, preventive measures may be indicated before surgery. For prevention of PTE, animals may be started on heparin during surgery and continued on it postoperatively (see Box 29.1) or they may be administered clopidogrel (2–3 mg/kg per day in dogs); however, prospective studies are needed to determine the relative benefit of these therapies. Many animals with HAC have clinically silent urinary tract infection; therefore urine culture is indicated in all patients, regardless of urinalysis findings.

Anesthesia with HAC patients

A variety of anesthetic protocols may be used in adrenocortical-insufficient or hyperadrenal animals. Etomidate causes transient adrenal suppression and should be avoided in patients with hypoadrenocorticism and those in which postoperative hypoadrenocorticism is anticipated. Steroid replacement should be provided in animals showing signs of adrenal insufficiency.

SURGICAL ANATOMY

The adrenal glands are near the craniomedial pole of the kidneys (Fig. 22.1). The left adrenal is slightly larger than the right. The left gland lies ventral to the lateral process of the second lumbar vertebra; the right adrenal is more cranial, lying ventral to the lateral process of the last thoracic vertebra. Because of the proximity of the right adrenal to the caudal vena cava, surgical removal of neoplastic glands can be difficult. The phrenicoabdominal (cranial abdominal) vessels cross the ventral surface of the adrenal. The adrenal glands are composed of two functionally and structurally different regions. The *outer cortex* produces mineralocorticoids (e.g., aldosterone), glucocorticoids, and small quantities of androgenic hormones. Mineralocorticoids regulate sodium and potassium concentrations. Aldosterone causes transport of sodium and potassium through the renal tubular walls and also causes hydrogen ion transport. The adrenal *medulla* is functionally related to the sympathetic nervous system and secretes epinephrine and norepinephrine in response to sympathetic stimulation. Epinephrine and norepinephrine have almost the same effects as direct sympathetic stimulation (e.g., vascular constriction, resulting in increased arterial pressure; inhibition of the gastrointestinal tract; pupillary dilatation; increased rates of cellular metabolism throughout the body), except that their effects last significantly longer because they are removed from the circulation slowly.

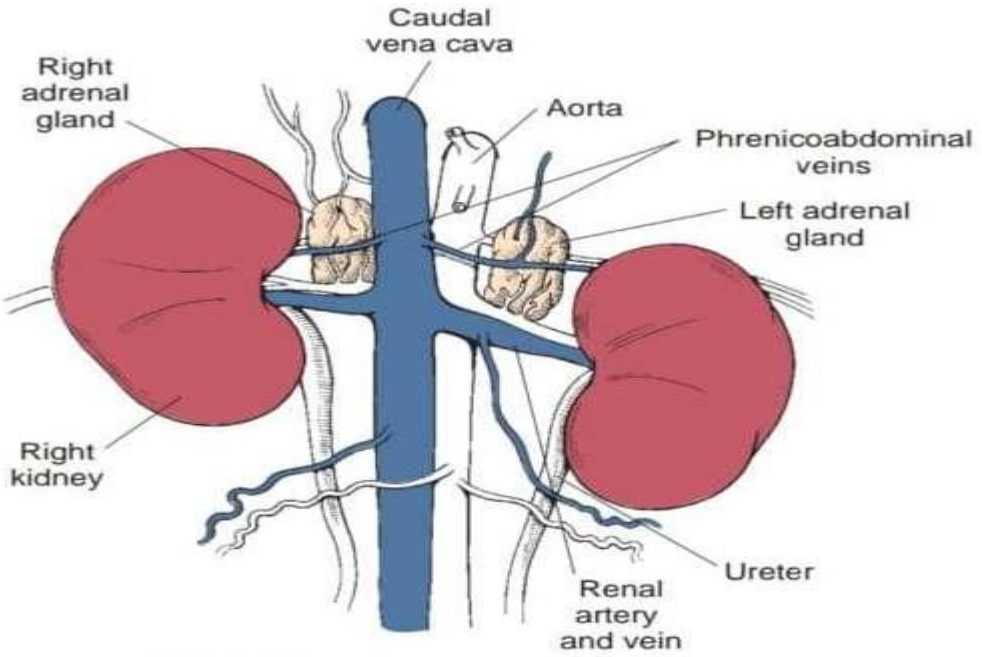


FIG. 22.1 Location of the adrenal glands.

BLOOD SUPPLY
Arterial Artery
• Arterial sources of flow:
– Branches from Inferior Phrenic Artery ⇨Superior Adrenal A.
– Direct visceral branches from Aorta ⇨Middle Adrenal A.
– Branches from I/L Renal Artery ⇨ Inferior
Adrenal A.
• The main adrenal arteries ⇨ branch to form a subcapsular plexus
• From subcapsular plexus
– Some branches continue directly ⇨ to medulla
– Others form sinusoids ⇨to cortex

Venous drainage

•Medullary veins coalesce to form adrenal vein
• Adrenal vein is surrounded by medullary tissue within the gland.
• Single main vein on each side
• Most important surgical structure
• Right adrenal vein
– Short
– Drains directly into post IVC
• Left adrenal vein
– Long as compared to right adrenal vein
– Joined by Inferior Phrenic vein prior to draining into Left Renal Vein
• The overlapping of both arterial and venous anatomy makes partial adrenalectomy possible with little risk of subsequent adrenal infarction

SURGICAL TECHNIQUE

Adrenalectomy is usually performed for adrenal tumors. Bilateral adrenalectomy for canine PDH is controversial and uncommonly performed, but it has been effective for feline PDH. One of two open approaches can be used, or alternatively a laparoscopic approach can be performed. A ventral midline approach allows the entire abdomen to be explored for metastasis and bilateral adrenalectomy to be performed with a single surgical incisionif necessary. However, exposure and dissection of the adrenal may be difficult with this approach, particularly in large dogs. A paracostal incision provides better access to the adrenal gland but

does not allow evaluation of the liver or other organs for metastasis. It may be considered in animals with unilateral lesions that have no evidence of metastasis on ultrasound, computed tomography (CT), or magnetic resonance imaging (MRI). Concurrent DM might be a contraindication to bilateral adrenalectomy because lack of endogenous catecholamines may make it difficult to regulate the diabetes. For laparoscopic adrenalectomy, dogs are positioned in lateral recumbency, with the adrenal gland to be removed on the up side. Dogs may also be positioned in sternal recumbency with the thorax and pelvis elevated, such that the abdomen is not in contact with the surgical table.1 This allows for gravitational displacement of the abdominal viscera and better visualization of the affected adrenal gland.

Adrenalectomy via a Midline Abdominal Approach

Prepare the entire ventral abdomen and caudal thorax for aseptic surgery. Make a ventral midline abdominal incision that extends from the xiphoid cartilage to near the pubis. Identify the affected adrenal gland and carefully inspect the entire abdomen, including the other adrenal gland, for abnormalities or evidence of metastasis. Palpate the liver for evidence of nodularity and biopsy if indicated. Palpate the caudal vena cava near the adrenal glands for evidence of tumor invasion or thrombosis. If additional exposure is necessary for adrenalectomy, extend the incision paracostally on the side of the affected gland by incising the fascia of the rectus abdominis muscle and the fibers of the external abdominal oblique, internal abdominal oblique, and transversus abdominis muscles, respectively. Use self-retaining retractors to improve visualization of the abdominal cavity. Retract the liver, spleen, and stomach cranially, the kidney caudally, and the caudal vena cava medially to expose the entire adrenal gland. Identify the blood supply and ureter to the ipsilateral kidney, and avoid these structures during dissection. Ligate the phrenicoabdominal vein and divide it between sutures. Using a combination of sharp and blunt dissection, carefully dissect the adrenal gland from surrounding tissue . Numerous vessels may be encountered. *Obtain hemostasis with electrocautery, a vessel-sealing device, or with hemoclips. If possible, do not invade the adrenal capsule. Remove the adrenal in one piece, if possible, to reduce the chances of leaving small pieces of neoplastic tissue in the abdominal cavity. If tumor thrombosis is present in the caudal vena cava but extensive metastasis is not apparent, temporarily occlude the vena cava using Rumel tourniquets. Make a longitudinal incision in the vein and remove the thrombus. Close the vena cava in a continuous pattern with 5-*

0 or 6-0 vascular suture, and close the abdomen routinely . If a paracostal incision was made, begin the closure by approximating the abdominal wall at the junction of the combined ventral and paracostal incisions. After closing the linea alba, suture each muscle layer of the paracostal incision with a continuous pattern of synthetic absorbable sutures. Close the skin and subcutaneous tissue routinely.

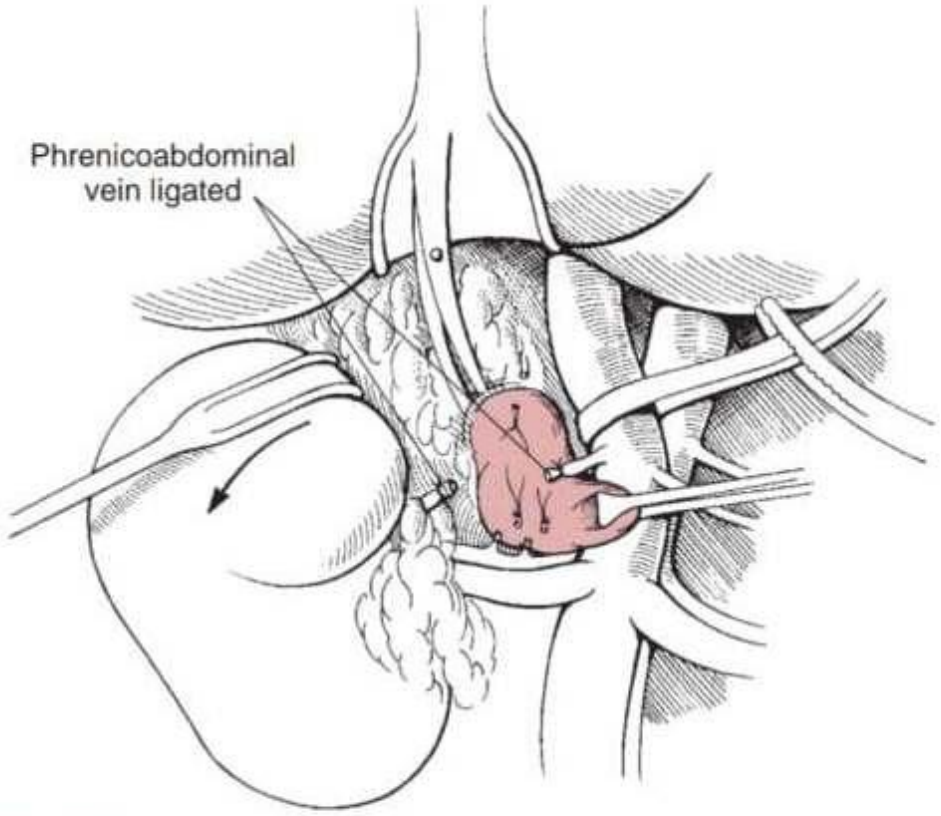


FIG. 22.2 To resect the right adrenal gland, retract the vena cava medially. Ligate the phrenicoabdominal vein and divide it between sutures. Carefully dissect the adrenal gland from surrounding tissue.

Adrenalectomy via a Paralumbar Approach

Place the patient in lateral recumbency with a rolled towel or a sandbag between the abdomen and the operating table. Prepare the caudal hemithorax and lateral abdomen for aseptic surgery. Make an incision just caudal to the 13th rib, extending it from the lateral vertebral processes to within 3 to 4 cm of the ventral midline (the incision will be approximately 10–14 cm long, depending onthe animal's size; Fig. 22.3). Incise the abdominal muscles individually and identify the adrenal gland

cranial to the kidney. Retract the kidney ventrally and ligate any vascular structures that cross its surface. Dissect the gland free from surrounding tissue (Fig. 22.4). Suture each muscle layer of the paracostal incision in a continuous suture pattern of synthetic absorbable (i.e., 2-0 or 3-0) material. Close the skin and subcutaneous tissues routinely.

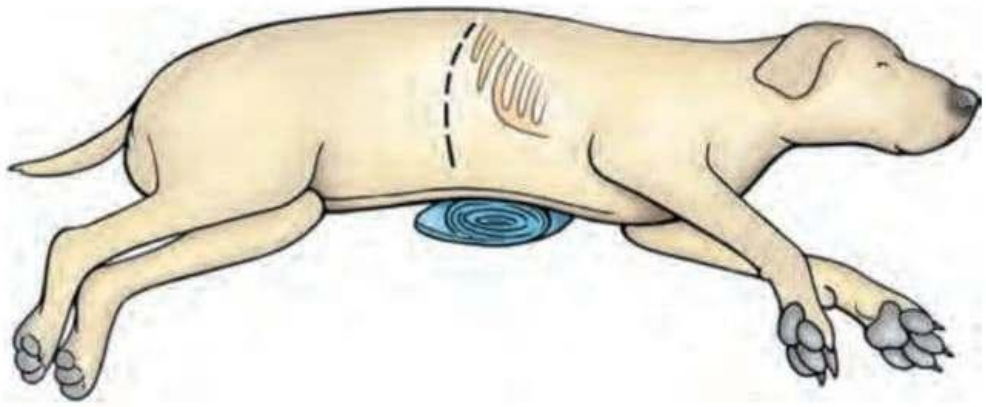


FIG. 22.3 Adrenalectomy may be performed via a paralumbar approach. Place the animal in lateral recumbency with a rolled towel or sandbag between the abdomen and the operating table. Make an incision just caudal to the 13th rib, extending it from the lateral vertebral processes to within 3 to 4 cm of the ventral midline.

Adrenal carcinomas are autonomously functioning, malignant tumors of the adrenal cortex; **adrenal adenomas** are benign adrenocortical tumors. **Pheochromocytomas** are catecholamine-secreting tumors of the chromaffin tissue, which usually arise in adrenal medullary tissue. Pheochromocytomas are also known as *paragangliomas.* "Incidentalomas" (incidental adrenal masses) are adrenal masses that are fortuitously found during imaging in animals that are not suspected of having adrenal disease. They may be carcinomas or pheochromocytomas, or they may be undefined, nonfunctioning masses.

Physical Examination Findings

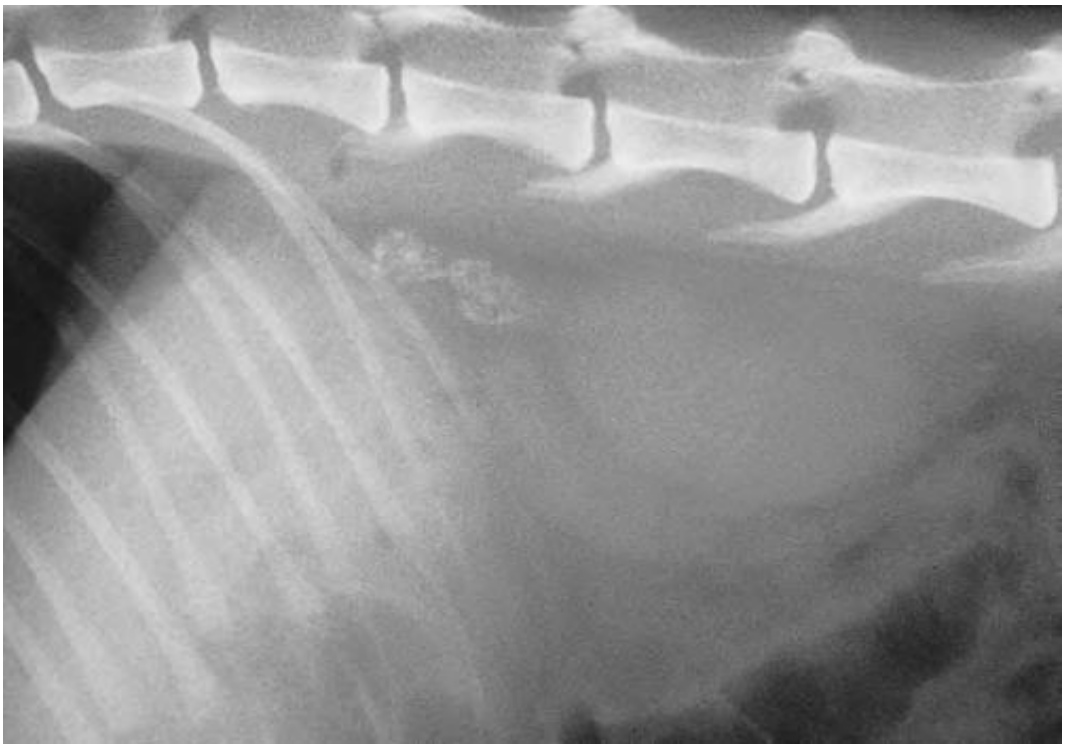
Clinical findings in animals with adrenocortical tumors depend on whether the tumors are functional. Dogs with ADH should have obvious signs of HAC (see previous discussion). Ascites, abdominal pain, edema, diarrhea, and vomiting are more common with nonfunctional tumors, although many are asymptomatic. Cats with hyperaldosteronism may have pelvic limb weakness, cervical ventroflexion, or a plantigrade stance. For cats presenting with blindness, there may be hyphema, retinal

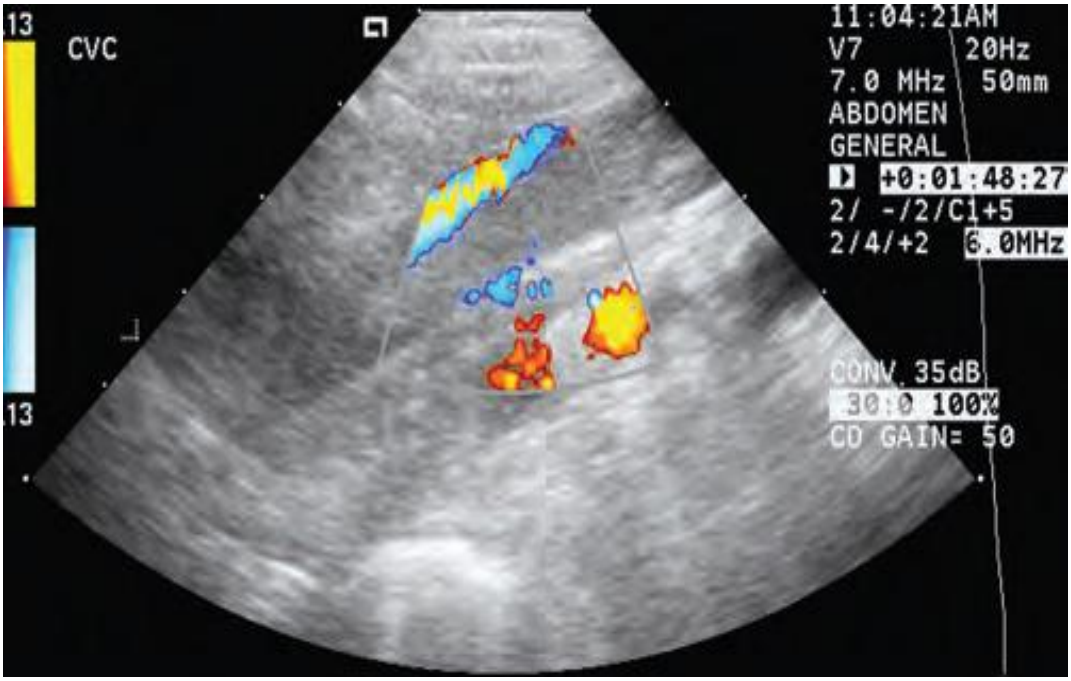
detachment, or intraocular hemorrhage. A palpable abdominal mass may also be noted in cats.

Clinical findings in animals with pheochromocytomas may include tachycardia or cardiac arrhythmia, acute collapse, polypnea, panting, cough, lethargy, anorexia, dyspnea, weakness, abdominal distention, congestive heart failure, ataxia, incoordination, polyuria-polydipsia, and alopecia. Hypertension (paroxysmal or sustained) is also frequently present. However, pheochromocytomas can be incidental findings in dogs that have no clinical signs associated with the tumor.

Diagnostic Imaging

Adrenal tumors are difficult to detect radiographically unless they are associated with significant adrenal enlargement (≥20 mm) or calcification. Food should be withheld for 24 hours before radiography to allow the gastrointestinal tract to empty. In some dogs, mineralization of tissue cranial to the kidney may be seen on survey radiographs and may or may not be associated with obvious adrenal enlargement. This finding is suggestive of adrenocortical neoplasia (adenoma or carcinoma). Nonneoplastic mineralization of adrenal glands is rare in dogs; however, bilateral adrenal calcification may occur with PDH. Conversely, adrenal gland mineralization is considered an incidental finding in cats (Fig. 22.5). Hepatomegaly, calcinosis cutis, or osteoporosis may be seen with PDH and ADH. Enhanced abdominal contrast caused by increased abdominal fat may occur. Dogs with HAC are more likely to have calcium-containing uroliths than dogs without clinical evidence of HAC. Although pheochromocytomas may be detected radiographically if sufficiently large, ultrasonography and CT are more sensitive.




CVC
11:04:21AM
V7
20Hz
7.0 MHz
50mm
ABDOMEN
GENERAL
+0:01:48:27
2/ -/2/C1+5
2/4/+2
6.0MHz
CONV 35dB
30:0 100%
CD GAIN= 50

SURGICAL TREATMENT

The overall health of the animal, the presence of nonresectable metastases, and the apparent invasiveness of the tumor (i.e., evidence of caudal vena cava thrombosis on CT or ultrasound) should be considered when the appropriateness of surgery for adrenal tumors is determined. Long-term survival (>1 year) may be possible, even in dogs with widespread metastatic lesions. If the tumor appears invasive, a midline abdominal approach is preferred to allow evaluation of the caudal vena cava and other abdominal structures. Thrombus removal may require that the midline incision be extended into the caudal thorax through a caudal median sternotomy approach. Thrombi more commonly occur because of intraluminal extension via the adrenal or renal vein, and less commonly by direct invasion. Caval thrombi occur in approximately one-fourth of dogs with adrenal gland tumors. They are more common with pheochromocytoma than with adrenocortical tumor, but they may occur with either. Venotomy may be used to remove tumors extending into the caudal vena cava. If venotomy cannot be performed, gradual occlusion of the caudal vena cava may allow removal of adrenal gland tumors with vascular invasion that would otherwise be difficult or impossible to resect; en bloc resection of the caudal vena cava during removal of a pheochromocytoma may also be performed. Small tumors and those that do not appear invasive may be removed through a paralumbar approach. Laparoscopic adrenalectomy has also been performed in dogs and cats.

Medical Treatment for Adrenal Tumors

Trilostane (Primary Drug Used for Adrenal Tumors)

1. Start with 1 mg/kg bid or 2 mg/kg once daily (twice daily is probably more effective). If that dose is insufficient, then gradually increase the dose orally with food. Observe for signs of lethargy, vomiting, diarrhea, or decreased appetite.
2. Perform a clinical examination, serum biochemistry profile, and ACTH stimulation 4–6 hours after the morning capsule on days 10–14.
3. Increase the dose until the owner reports a good clinical response and the post-ACTH serum cortisol is <9 µg/dL.

Mitotanea

1. Administer 50–75 mg/kg once daily with food plus 0.2 mg/kg prednisolone/day. Observe for signs of lethargy, vomiting, diarrhea, or decreased appetite. Recheck dog in 10–14 days. If no response, then increase dose by 50 mg/kg/day.

2. Perform ACTH stimulation test. Appropriate response is ACTH-stimulated cortisol <1 µg/dL. If patient is responding, decrease mitotane to 75–100 mg/kg/wk and continue prednisolone. If no response at 14 days, then increase mitotane by 50 mg/kg/day (continue prednisolone) for another 14 days and recheck.