Key Points:
- Surgical treatment of thyroid and parathyroid disease commonly carries a good prognosis provided appropriate post-operative monitoring is employed.
- Preoperative imaging is important to identify good surgical candidates and minimize intra-operative and post-operative complications.

Thyroid Surgery

_anatomy:_

The thyroid gland in dogs and cats consists of two glands on either side of the cranial trachea, with the left gland located slightly more caudal than the right. The right thyroid gland usually begins at the caudal border of the cricoid cartilage, and the glands span 5 to 8 tracheal rings, depending on the dog’s size. Occasionally dogs will have a parenchymal connection between the two glands running across the ventral aspect of the trachea. In cats, the thyroid glands are generally 1cm long and are flatter and paler than canine thyroid glands.

The blood supply to the thyroid gland is derived from the cranial thyroid artery (arising from the common carotid artery) and the caudal thyroid artery (arising from the brachiocephalic artery), which anastomose at the gland and give off smaller branches that travel directly to the gland. The caudal thyroid artery is absent in cats. These arteries have matched veins, and some dogs will have an additional unpaired vein that runs ventrally across the trachea. Also of note are the recurrent laryngeal nerves which travel dorsally and usually medial to the thyroid glands and must be carefully avoided during thyroidectomy. Other nearby structures that may be affected by thyroid tumors include the trachea, esophagus, jugular veins (internal and external), common carotid artery, and vagosympathetic trunk. Lymphatic drainage is via the right lymphatic duct and left tracheal duct to local lymph nodes, primarily the medial retropharyngeal.

_Preoperative Diagnostics:_

Most thyroid masses are detected on physical examination, although some may present as incidental findings on imaging for other conditions. Cervical ultrasound is useful in identifying thyroid masses and distinguishing them from masses arising from other structures. Feasibility of resection, however, is most effectively determined by physical examination and computed tomography. CT may also help identify potentially metastatic lymph nodes. Characteristics evaluated on physical exam and CT that help determine surgical resectability include laterality and invasion. Historically, unilateral, moveable thyroid masses were considered surgically resectable, while dogs with bilateral or fixed/immobile masses were considered to be poorer surgical candidates. Many bilateral and fixed thyroid masses are actually surgically resectable, although the risks of hemorrhage and damage to surrounding structures may be increased. For palpably moveable, unilateral thyroid tumors, a CT may provide little additional benefit. For fixed and bilateral tumors, however, a CT may be very useful in determining whether surgery is feasible or whether invasion into nearby structures (esophagus, trachea, etc.) is severe enough to deter surgical resection. Thoracic radiographs and/or CT are appropriate to evaluate for pulmonary metastasis. Scintigraphy is often not necessary but can be useful in localizing ectopic hyperactive thyroid tissue, particularly in cats with hyperthyroidism.
While cytological assessment of thyroid masses may be obtained via ultrasound-guided fine needle aspirate, the inability of cytology to definitively distinguish benign from malignant masses limits its utility, as surgical resection is generally recommended regardless of cytological description. Histopathological diagnosis via biopsy is avoided due to the high risk of hemorrhage from thyroid masses and is thus only obtained following surgical resection. Given the limitations of these diagnostics, most surgeons are comfortable proceeding to thyroidectomy based on imaging alone. Historically, the vast majority of dogs with thyroid tumors are euthyroid, leading to some to forego evaluating serum thyroid levels. At the author’s institution, more dogs have presented with tumor-associated hyperthyroidism than the literature would predict, and other surgeons have expressed similar anecdotal findings; for this reason, it is recommended that thyroid function be evaluated for any dog presenting with a thyroid mass. Depending on the mass’s size, level of invasion, and perceived vascularity, evaluation of the patient’s coagulation status and blood type prior to surgery is indicated should the need for blood transfusion arise intra-operatively. Coagulation abnormalities should be addressed prior to pursuing surgical excision of an invasive thyroid mass.

**Surgery:**

Surgical excision of small, unilateral, moveable thyroid masses is straightforward: a ventral midline incision is made along the cervical region, beginning at or just caudal to the cricoid cartilage. The palpable mass can be used to guide length of the incision. Rolled towels may be placed under the neck just caudal to the head to gently elevate the surgical site toward the surgeon. The sternohyoideus and sternothyroideus muscles are bluntly separated along midline, and Gelpi or Weitlaner retractors used to maintain exposure; blunt-tipped self-retaining retractors are preferred to minimize the risk of iatrogenic injury to surrounding structures. The trachea is identified, and the thyroid glands can be located on either side of the cranial trachea using blunt dissection. Care should be taken to identify and protect the recurrent laryngeal nerves running lateral to the trachea.

Four techniques have been described for removal of thyroid glands; these are more relevant, however, to removal of adenomatous thyroid tissue in cats with hyperthyroidism rather than removal of a canine thyroid tumor where the thyroid usually incorporates the ipsilateral parathyroid glands. The four techniques are briefly described below:

- **Intracapsular:** an incision is made into the thyroid capsule with blunt dissection to remove the thyroid parenchyma, leaving behind the capsule and external parathyroid gland. This method is accompanied by a higher risk of recurrence of hyperthyroidism in cats.
- **Modified intracapsular:** an incision is made into the thyroid gland capsule and the thyroid parenchyma is dissected, preserving the external parathyroid gland and parathyroid artery. Thyroid parenchyma and capsule is then removed aside from a small cuff of capsule left adjacent to the external parathyroid gland.
- **Extracapsular:** the intact thyroid gland is removed with the associated external parathyroid gland; this technique is accompanied by a high rate of hypoparathyroidism in animals with bilateral disease.
- **Modified extracapsular:** the external parathyroid gland and associated capsule are gently separated from the thyroid gland while preserving the parathyroid artery. The thyroid artery is ligated distal to the branching of the parathyroid artery, and the thyroid gland is removed.
The modified intracapsular technique is preferred by many surgeons for cats with hyperthyroidism. Bipolar cautery, cotton-tipped applicators, and iris scissors are extremely helpful for the fine dissection required for feline thyroidectomy. For resection of canine thyroid tumors, the abnormal thyroid gland and associated parathyroid glands are removed en masse. With unilateral tumors, this is unlikely to lead to significant hypocalcemia given the presence of the two contralateral parathyroid glands, neither of which should be suppressed by a thyroid tumor. Unlike hyperplastic adenomatous thyroid tissue in cats, many thyroid tumors in dogs have significant neovascularization, often in the form of multiple small vessels traversing the thyroid tumor capsule. Tumor extension into the cranial or caudal thyroid veins may also cause venous engorgement. Occasionally, structures including the external jugular vein, recurrent laryngeal nerves, common carotid artery, or vagosympathetic trunk may also be incorporated with larger, fixed tumors. Dissection of these tumors is best approached with careful dissection using right angle forceps, bipolar cautery, and hemoclips. For larger and more vascular tumors, a small, precise vessel sealing device such as the Harmonic Focus® or the LigaSure™ Small Jaw handpieces greatly improve speed of dissection and hemostasis. The author prefers to begin dissection laterally and caudally, ligating or sealing the cranial and caudal thyroid vasculature as encountered, along with additional neovascularization warranting hemostasis. Capsular disruption should be minimized in order to prevent significant bleeding that may further obscure visualization. The surgeon should also be mindful of the recurrent laryngeal nerve while dissecting medially and dorsally, particularly when the nerve has not been identified prior to commencing dissection.

Parathyroid autotransplantation is a described method of re-implanting the external parathyroid gland into a small incision in the sternohyoideus or sternothyroideus muscle when the external parathyroid gland is inadvertently excised or devascularized.\(^1\) Parathyroid tissue revascularizes and begins secreting parathyroid hormone within 7 to 21 days. This technique is feasible with thyroidectomy for hyperfunctional adenomatous tissue in cats, but it is often challenging to identify parathyroid tissue in larger thyroid tumors seen in dogs. A retrospective study evaluating the removal of bilateral thyroid tumors in 15 dogs found that autotransplantation of parathyroid tissue did not appear to have a consistent effect on the development of post-operative hypocalcemia in these dogs.\(^3\) Furthermore, reimplantation of parathyroid tissue carries the theoretical risk of seeding and revascularizing diseased tissue.

Complications and Prognosis:

Complications of thyroidectomy include hemorrhage, post-operative hypocalcemia, laryngeal paralysis secondary to recurrent laryngeal nerve injury, persistent hyperthyroidism (in cats), post-operative hypothyroidism (with bilateral thyroidectomy), and local recurrence or progression of disease. Most cats treated for hyperthyroidism with surgical excision have sustained resolution of hyperthyroidism despite the presence of ectopic thyroid tissue in some cats. In a study of 101 cats treated surgically for hyperthyroidism, only 4 of 9 cats with ectopic tissue had recurrence of hyperthyroidism.\(^4\)

The prognosis for dogs with surgically excised thyroid tumors is generally good in the absence of metastatic disease. Median survival time for dogs undergoing surgical excision of bilateral thyroid carcinomas was 38.3 months in a recent retrospective study.\(^3\) That study also demonstrated that recurrent laryngeal nerve damage during tumor excision does not necessarily manifest as clinical laryngeal paralysis. With bilateral thyroidectomy, both postoperative thyroid status and calcium levels should be monitored, as lifelong supplementation may be necessary.
Parathyroid Surgery

Anatomy:

Dogs and cats have 4 parathyroid glands located in close association with the thyroid glands. Approximately 3-6% of dogs and 35-50% of cats have ectopic parathyroid tissue, usually located within the neck and thorax, often alongside the trachea. The parathyroid glands are divided into external glands along the cranial dorsolateral margin of the thyroid glands, and the internal parathyroid glands which are embedded within the caudal pole of the thyroid gland. The exact positioning of the internal and external parathyroid glands is variable, and occasionally external parathyroid glands may be located adjacent to rather than in contact with the thyroid gland or rarely within the thyroid parenchyma. Blood supply to the parathyroid glands comes from branches of the cranial and caudal thyroid arteries.

Preoperative Diagnostics:

Abnormal parathyroid nodules are usually identified via cervical ultrasound. Abnormal glands are usually anechoic or hypoechoic compared to thyroid tissue and are larger than normal parathyroid glands. Median diameter of hyperfunctional parathyroid glands was found to be 6 mm compared to 3 to 4.6 mm for normal glands depending on the size of the dog. Due to glandular atrophy in the face of hypersecretion of PTH, often only one nodule is identified in affected dogs. Ultrasound findings correlated with surgical findings in 93% of dogs. Additional imaging via computed tomography or magnetic resonance imaging may also identify abnormal parathyroid tissue, particularly when ultrasound does not identify a suspected lesion. Parathyroid scintigraphy has not been demonstrated to be a useful imaging modality in dogs. While CT and MRI may help identify ectopic parathyroid tissue, many surgeons prefer to explore the cervical region along the trachea surgically if ultrasound and initial surgical evaluation of the thyroid-parathyroid complexes does not reveal an abnormal lesion. Due to the fact that ectopic parathyroid tissue may be found as far caudally as the heart, exploring the neck surgically without additional imaging carries the risk of missing intrathoracic parathyroid tissue, although these lesions are rarely reported.

In patients with suspected primary hyperparathyroidism, ionized calcium should be measured to confirm true hypercalcemia, and PTH and PTH-rP levels should be evaluated to confirm the source of the hypercalcemia. In the face of hypercalcemia, PTH should be low; a normal or high PTH with concurrent hypercalcemia is consistent with primary hyperparathyroidism, whereas an elevated parathyroid hormone-related protein (PTH-rP) indicates hypercalcemia of malignancy. It is important to note that a negative PTH-rP does not rule out hypercalcemia of malignancy.

Surgery:

The surgical approach for parathyroidectomy is similar to that described above for thyroidectomy. Magnification via loupes is useful for identifying abnormal glands, and bipolar cautery, fine-tipped forceps, iris scissors, and cotton-tipped applicators are useful for isolating the implicated gland. Both thyroid-parathyroid complexes should be visually inspected to confirm correlation with pre-operative ultrasound. Abnormal external parathyroid glands (identified as enlarged and often firm) are removed using sharp dissection or electrocautery to incise the capsule adjacent to the parathyroid gland and a cotton-tipped applicator to gently separate the parathyroid gland from the adjacent thyroid parenchyma. Hemostasis is achieved
with electrocautery. For internal parathyroid glands, or any gland embedded within the thyroid parenchyma, a partial thyroidectomy may be performed using a guillotine technique. With this technique, an encircling ligation is placed around the mid-body of the affected thyroid gland and the affected thyroid tissue distal to the ligation is sharply excised. If there is any question as to the blood supply to the remaining portion of the thyroid gland, the entire thyroid-parathyroid complex may be removed via a unilateral thyroidectomy.

If no abnormal parathyroid gland is identified on initial inspection, the incision may be extended to the manubrium, and the cervical region explored, focusing on tissue immediately adjacent to the trachea and surrounding tissues. If no lesion is subsequently identified, the surgeon may choose to remove a single thyroid-parathyroid complex or abort surgery to pursue additional imaging and diagnostics. Intraoperative PTH measurements can also be used to confirm successful removal of the affected tissue, with a >50% decrease in PTH 30-45 minutes following excision indicating excision of the hyperfunctional tissue.6

Complications and Prognosis:
Intraoperative complications of parathyroid surgery are rare. The most prevalent concerns are those related to post-operative management, specifically the development of post-operative hypocalcemia. With careful monitoring to avoid the risks associated with hypocalcemia, dogs with primary hyperparathyroidism have a good prognosis, with rates of recurrence of hypercalcemia in dogs ranging from 4 to 17%.7 In dogs with higher pre-operative calcium levels, post-operative renal failure may become apparent and renal values should be evaluated post-operatively. Although rare, parathyroid carcinoma is reported, and any excised parathyroid glandular tissue should be submitted for histopathology.8

References