Anesthetic Management in a Hyperthyroid Cat

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THE CASE

Buttercup, a 12-year-old spayed domestic shorthair cat, is presented for a preanesthetic examination prior to removal of a previously diagnosed, ulcerated basal cell carcinoma on the dorsal aspect of the neck measuring 1.0 × 1.0 × 0.5 cm.

Buttercup had been diagnosed with hyperthyroidism 4 months prior and was initially treated with methimazole; however, because of intolerable side effects (ie, pruritus, diarrhea), she was switched to a low-iodine prescription diet. Her owner reports that Buttercup has shown clinical improvement (ie, less polyuria/polydipsia and vomiting) since starting the low-iodine diet.

An echocardiogram performed when hyperthyroidism was first diagnosed showed mild eccentric hypertrophy of the left ventricle, thickening of the intraventricular septum, and benign right ventricular outflow tract obstruction.

CBC and serum chemistry profile results from 4 days before presentation are relatively unremarkable, other than a mildly elevated ALT of 185 U/L (reference range, 27-158 U/L) and blood glucose of 198 mg/dL (reference range, 72-175 mg/dL). Total thyroxine (TT4) is still elevated at 5.5 µg/dL (reference range, 0.8-4.7 µg/dL) but is greatly improved from 4 months prior, when TT4 was 10.3 µg/dL.

MAP = mean arterial pressure
TT4= total thyroxine

On physical examination, the patient is thin (BCS 3/9) and appears euhydrated. She is visibly nervous and resists restraint, behavior that is atypical from her previous visits. Temperature is 102.5ºF (39.2ºC), heart rate is 254 bpm, and respiratory rate is 51 breaths/min. A grade 2/6 systolic parasternal murmur and gallop rhythm are present with synchronous and bounding pulses. Lungs are clear on auscultation, but increased effort is noted. A thyroid slip is palpable. Average blood pressure* after 5 readings is 196/93 mm Hg (MAP, 127 mm Hg). The owner expresses concern that Buttercup has not been this agitated at home and became more upset in the waiting room when surrounded by dogs.

WHAT IS THE APPROPRIATE NEXT STEP?

OPTION 1

Prepare Buttercup for anesthesia and surgery. Instruct veterinary nurses to place a catheter as quickly as possible so that IV sedation can be administered to reduce the patient's stress.

OPTION 2

Postpone anesthesia and surgery because of the patient's signs of agitation and unregulated hyperthyroidism.

*All blood pressure values are provided in a systolic/diastolic (mean arterial pressure [MAP]) format.

OPTION 1

Prepare Buttercup for anesthesia and surgery. Instruct veterinary nurses to place a catheter as quickly as possible so that IV sedation can be administered to reduce the patient's stress.

Case Progression

As Buttercup is restrained for a catheter, she becomes aggressive. She begins open-mouth breathing and will not allow anyone to touch her. A team member suggests "boxing" her down to avoid the need for an intramuscular injection, which would likely further stress the patient.

The patient is placed in an anesthetic chamber, and oxygen is delivered at a flow rate of 6 L/min. Three minutes later, 5% isoflurane is started. The patient becomes visibly upset but quickly becomes anesthetized. She is removed from the chamber, intubated immediately with a 4.5-mm cuffed endotracheal tube, and attached to a pediatric circle rebreathing system with 100% oxygen delivery.

Mucous membranes are pale and cyanotic. On auscultation, there is no heartbeat, and crackles are auscultated when positive pressure ventilation is initiated. ECG leads and an $ETCO_2$ monitor are attached and demonstrate cardiopulmonary arrest. Cardiac compressions are initiated and epinephrine (0.1 mg/kg) is administered via the endotracheal tube. Team members are unable to place a catheter. The patient does not respond to the initial epinephrine dose, so an additional 0.1 mg/kg is administered intratracheally. After 3 minutes, no pulse or electrical activity is present. Epinephrine (0.1 mg/kg) is administered via intracardiac injection with no change. The owner is contacted and cardiopulmonary cerebral resuscitation is discontinued.

Hyperthyroidism is the most common endocrine disease in middle-age to older cats.[1]

MAP = mean arterial pressure

OPTION 2

Postpone anesthesia and surgery because of the patient's signs of agitation and unregulated hyperthyroidism.

Case Progression

The level of agitation and other signs of sympathoadrenal stimulation are concerning, as these can be associated with the onset of acute stress-induced thyrotoxicosis. Also, despite the low-iodine diet, Buttercup's TT4 is still elevated. The owner understands the risk but is concerned about the tumor advancing and wants to pursue removal as soon as possible. To counteract some of the sympathetic stimulatory effects of excess thyroid hormones, atenolol (6.25 mg PO q24h) is prescribed. Buttercup is scheduled to come back one week later at a time when no dogs are present in the waiting room and when she can be admitted and sedated immediately to minimize stress. The owner is instructed to monitor Buttercup throughout the day, keep her in a cool environment, and call immediately if she begins open-mouth breathing or demonstrating other abnormal behavior.

The following week, Buttercup is presented before other patients arrive at the clinic. A physical examination is performed while the owner holds her. Heart rate is 150 bpm with strong, synchronous pulses, and a murmur is still auscultable and now graded at 1/6. Respiratory rate is 24 breaths/min, and the patient is eupneic, with no adventitial sounds on auscultation. Oscillometric blood pressure is 132/85 mm Hg (MAP, 101 mm Hg). The patient is sedated with oxymorphone (0.1 mg/kg IM), midazolam (0.2 mg/kg IM), and alfaxalone (1 mg/kg IM). Flow-by oxygen is delivered while she is becoming sedate, and ECG leads are attached once she is noticeably relaxed. A cephalic catheter is placed and IV crystalloids (3 mL/kg/hr) are started.

Before induction of anesthesia, vital signs are rechecked and are stable. Anesthesia is induced with an additional dose of alfaxalone (1.5 mg/kg IV), and the patient is intubated with a 4.5-mm cuffed endotracheal tube.

Following intubation, 1.5% isoflurane in oxygen (1 L/min) is delivered, and remaining monitors (ie, pulse oximeter, oscillometric blood pressure, temperature probe, capnograph) are attached. A convective warming blanket is placed over the patient to maintain normothermia.

Before surgery, Buttercup becomes mildly hypotensive, with a blood pressure of 90/39 mm Hg (MAP, 56 mm Hg). Heart rate is unchanged. Anesthetic depth appears adequate (ie, no palpebral reflex, ventromedial rotation of eye, decreased jaw tone), so a crystalloid bolus (10 mL/kg IV) is administered over 10 minutes while the patient is clipped, prepped, and draped. As the first incision is made, hypotension resolves; the patient remains stable for the remainder of surgery. Before closure, 0.5% topical bupivacaine (1 mg/kg) is applied to the open wound site.

Recovery is uneventful. Buttercup tenses slightly as her incision is palpated, prompting administration of an additional dose of oxymorphone (0.05 mg/kg IV) and application of an ice pack to the incision. She is hospitalized overnight for continued monitoring and pain management (buprenorphine 0.015 mg/kg IV q8h) and discharged in the morning without incident.

DISCUSSION

Hyperthyroidism is the most common endocrine disease in middle-age to older cats.[1] Excessive production of thyroid hormone

creates a hypermetabolic state that strains the cardiopulmonary system. Anesthesia carries greater risk to patients with hyperthyroidism, regardless of the actual plasma concentration of TT4; therefore, it is generally recommended that patients receive treatment and be rendered euthyroid before elective anesthesia.[2]

Buttercup did not tolerate antithyroid medication and was being controlled by diet alone. Incomplete resolution of hyperthyroidism can place the practitioner in a difficult situation when faced with a need to perform anesthesia and requires a thorough and well documented discussion with the owner regarding anesthetic risk.

Cardiovascular Effects of Hyperthyroidism

Thyroid hormones exert both positive inotropic and chronotropic effects on the heart. This results from direct effects on ion channels and cardiac myocytes as well as an upregulation of β-adrenergic receptors that heightens myocardial sensitivity to catecholamines. In addition, total triiodothyronine (TT3) causes relaxation of vascular smooth muscle, which decreases systemic vascular resistance and activates the renin-angiotensin-aldosterone system. The resulting increase in preload and cardiac output increases myocardial oxygen demand and can lead to structural changes to the heart consistent with volume overload.[3]

Elective anesthesia and surgery should not be attempted if thyrotoxicosis is suspected.

Anesthetic Concerns

Acute thyrotoxicosis affects cats and can be initiated by both thyroidal and nonthyroidal illness (eg, stress, infection, trauma). Signs include agitation, nervousness, hyperthermia, tachycardia, tachypnea, and respiratory distress.[2] Buttercup's initial presentation was consistent with impending thyrotoxicosis. Eliminating the precipitating cause (ie, stress), providing supportive care (eg, oxygen therapy), and blocking the actions of circulating thyroid hormones by decreasing sympathoadrenal stimulation are necessary. Elective anesthesia and surgery should not be attempted if thyrotoxicosis is suspected, as significant tachyarrhythmias, congestive heart failure, and cardiovascular collapse could result.

Preparation for Anesthesia

Many of the effects of hyperthyroidism can be counteracted by blocking sympathetic nervous system activity. β-blockers (eg, atenolol) may help reduce heart rate when administered several days before anesthesia.[2,5] The nonselective β-antagonist propranolol has the added benefit of decreasing conversion of TT4 to TT3 peripherally and has been shown to lower TT4 levels following short-term administration.[6] β-blockers decrease myocardial oxygen demand and allow for better ventricular filling, especially in situations of thyrotoxic cardiomyopathy that may result in impaired relaxation of the heart (diastolic dysfunction).

Minimizing stressors in the hospital environment can also help subdue excessive sympathetic stimulation. Providing a quiet area specifically for cats, allowing owners to hold their pet during examinations, and premedicating patients before catheter placement may help facilitate this.

Drugs that stimulate the sympathetic nervous system (eg, induction agents, ketamine, sympathomimetic drugs [eg, anticholinergics]) should be avoided in hyperthyroid patients.[7]

The ensuing tachycardia from these agents can shorten diastolic filling time, causing myocardial hypoxia and potentially fatal arrhythmias.

In this case, good preanesthetic sedation was desired to minimize stress and facilitate handling. Combining low doses of oxymorphone, midazolam, and alfaxalone can produce excellent sedation while minimizing adverse effects. Alfaxalone, an induction agent that works on the $GABA_A$ receptor, has similar cardiopulmonary effects as propofol (eg, vasodilation, dose-dependent apnea) but can be administered intramuscularly.

Preoxygenation is advised in patients with increased oxygen demand, as in this case, to help prevent hypoxemia until an airway can be established. In addition, placing monitoring equipment before induction allows the anesthetist to observe changes in the patient's cardiovascular status and identify problems rapidly. In Option 1, use of an anesthetic chamber prevented the ability to monitor anesthetic depth or cardiac status and delayed identification of cardiac arrest.

After induction of anesthesia, Buttercup became hypotensive. Although hypertension is commonly associated with hyperthyroidism, significant hypotension can also occur from the combined peripheral effects of TT3 with anesthetic drugs that cause vasodilation (eg, alfaxalone, isoflurane). In Option 2, once anesthetic depth was determined to be adequate, a crystalloid bolus was administered during surgery preparation. Although a bolus of this size should be tolerated given the mild changes in Buttercup's echocardiogram, other options could have included starting a fentanyl CRI and decreasing the isoflurane concentration further.

Although uncommon, acute thyrotoxicosis can occur with the patient under anesthesia, and the practitioner should be prepared. Having vascular access and emergency drugs drawn in the event of cardiac arrest can be potentially life-saving. β-blockers (eg, esmolol) and antihypertensives (eg, nitroprusside) are often used to control supraventricular tachyarrhythmias and hypertension, respectively.[7] Administration of potassium iodate or iodinated contrast agents reportedly suppresses the thyroid gland from releasing preformed thyroid hormones through an autoregulatory mechanism.[2,8] In patients like Buttercup controlled with a low-iodine diet, however, this could backfire, as these agents provide iodine to an iodine-deficient thyroid gland, potentially exacerbating thyroid hormone production and release. Of note, administration of these agents is not common nor without potential adverse effects.

Glucocorticoids decrease thyroid hormone levels via multiple mechanisms in dogs and are currently recommended in the therapeutic treatment of humans with acute thyrotoxicosis.[1,8] Although not reported—and understanding the potential risks in cats with pre-existing cardiac disease—this may offer another treatment option in cats in which thyrotoxicosis is suspected.

The goal of reducing sympathetic stimulation should continue through the recovery period. Maintaining normothermia, ensuring adequate volume status, and providing excellent pain management can all alleviate stress in the immediate postoperative period. In patients receiving β-blockers, continuing treatment for several days after surgery is advised. Managing the unregulated hyperthyroid patient can be challenging and unpredictable. When faced with a patient that may be experiencing acute thyrotoxicosis, carefully evaluating the situation and having an open conversation with the owner regarding anesthetic risk is prudent. Postponing an elective procedure to allow better preparation may be the best alternative.

TT3 = total triiodothyronine
TT4= total thyroxine

References

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