

Adam C. Adler

An 11-year-old female presents for subtotal thyroidectomy for Graves' disease. She has been treated with methimazole for the past three months and has a visibly enlarged anterior neck mass.

What Is Graves' Disease?

Graves' disease is the most common cause of hyperthyroidism in children. It is more common in females and often presents during the teenage years. It is an autoimmune disease in which thyroid-stimulating hormone (TSH)-receptor antibodies cause overproduction of TSH that activates the thyroid gland causing thyroid growth (goiter) and high levels of thyroid hormones. Common symptoms include tachycardia, tremors, weight loss, muscle weakness, heat intolerance, and insomnia. Some patients may demonstrate exophthalmos, an outward bulging of the eyes caused by periorbital inflammation, but this is less common in children. Medical management includes administration of antithyroid drugs, such as methimazole, radioactive iodine, or subtotal thyroidectomy when medical management fails or when the thyroid is large and unsightly. Surgical cure must be accompanied by lifetime administration of exogenous thyroid hormones. Beta blockers may be used to suppress palpitations, tachycardia, and tremors. In our patient, it is likely that her surgical intervention is mainly cosmetic and has been scheduled following a course of methimazole to ensure that her thyroid function is closer to normal at the time of surgery.

What Preoperative Laboratory Studies Are Indicated in This Patient?

Adequate thyroid suppression is evidenced by low or normal levels of circulating total T₃ and free T₄ as well as resolution of symptoms. A complete blood

count should be obtained because of the rare occurrence of pancytopenia with antithyroid therapy.

Is a Cardiac Evaluation Warranted?

Depending on the duration of symptoms, Graves' disease patients are at risk for developing tachycardia-induced cardiomyopathy, but this is extremely rare in the pediatric population. Prolonged duration of untreated symptoms of tachycardia resulting from excessive circulating thyroid hormone can lead to dilated heart failure. Often, symptoms of heart failure can be identified by history. Chest radiograph can reveal an enlarged heart although in severe and prolonged cases, transthoracic echocardiography may be beneficial in identifying cardiac pathology prior to anesthesia.

How Is the Airway Evaluated in the Setting of a Large Thyroid Mass?

Patients should be questioned regarding their ability to lie supine and presence of dyspnea or dysphagia, which may reveal posterior compression of the airway and esophagus (Figure 34.1). A CT scan is helpful to assess upper airway compression. If significant airway compression exists, especially in the setting of dyspnea while supine, it may be prudent to perform tracheal intubation while the patient is breathing spontaneously (see Chapter 19). This is exceedingly rare in the pediatric population.

What Is a NIM Tube, and Why Is It Used for Thyroidectomy?

A neural integrity monitoring (NIM) tube is a specialized endotracheal tube for assessment of neural integrity during neck dissection. Electrodes on the endotracheal tube at the level of the vocal cords record stimulation of the laryngeal nerves. The proper



Figure 34.1 Gross thyroid specimen. The bulk of tissue seen here demonstrates the ability for the external mass to affect the airway. Additionally, this allows the provider to imagine the difficulty that would ensue during an attempted emergency tracheostomy trying to reach and identify the underlying trachea quickly and without causing significant bleeding. Courtesy of Adam C. Adler, MD

color-coded segment must be positioned between the vocal cords and is often done using a video laryngoscope to allow for visualization by surgical staff during placement.

What Is the Risk If a Recurrent Laryngeal Nerve Is Injured or Transected During the Surgical Procedure?

The recurrent laryngeal nerve is a branch of the vagus nerve and supplies all muscles of the larynx except the cricothyroid muscle. The cricothyroid muscle is a vocal cord tensor and is supplied by the superior laryngeal nerve. Recurrent laryngeal nerve damage results in unopposed action by the cricothyroid muscle causing closure of the vocal cords. Use of the NIM tube attempts to avoid accidental nerve damage by deliberate stimulation during dissection.

Identify the Timeframe and Causes of Postoperative Airway Obstruction

Immediate postoperative airway compromise following removal of the endotracheal tube is often the result of damage to the recurrent laryngeal nerves causing the vocal cords to obstruct the airway. As this complication is often unilateral, patients present with hoarseness or stridor.

Acute airway obstruction from a hematoma can occur immediately postoperatively and is the most frequent cause of airway obstruction in the first 24 hours. In the PACU, postoperative airway obstruction

Table 34.1 Symptoms and timeframe of airway obstruction following thyroid surgery

Postoperative timeframe	Cause	Symptoms
Acute onset	Recurrent laryngeal nerve injury	Unilateral: hoarseness Bilateral: aphona, airway obstruction
Acute to 24 hours	Hematoma formation	Acute to delayed hematoma formation resulting in external airway compression
24–48 hours	Hypocalcemia / trauma or complete parathyroidectomy	Signs of hypocalcemia

should raise immediate concern for a developing hematoma and may necessitate surgical reexploration.

Twenty-four to forty-eight hours postoperatively, airway obstruction may be the result of accidental total parathyroidectomy or ischemia to the remaining parathyroid tissue. Hypoparathyroidism results in decreased production of parathyroid hormone resulting in decreased serum calcium. Hypocalcemia generally presents at 24–48 hours as laryngeal stridor and airway obstruction as calcium depletion does not occur immediately (Table 34.1).

What Are the Signs/Symptoms of Hypocalcemia?

Symptoms of hypocalcemia may include tingling of the lips and fingertips. Additional findings may develop, including carpopedal spasm, tetany, laryngospasm, seizures, QT prolongation, and cardiac arrest.

Examination: Chvostek's sign or elicited facial contraction following tapping the facial nerve in the per-auricular area and Trouseau's sign or carpal spasm on inflation of a blood pressure cuff.

Administration of one gram of calcium gluconate is generally sufficient in the immediate setting.

What Is Thyroid Storm?

Thyroid storm is a hypermetabolic state characterized by excessive thyroid hormone levels. This leads to excessive oxygen consumption and systemic sympathetic activation causing multiorgan failure. Thyroid storm is life threatening and requires immediate recognition and treatment. Recognition of thyroid storm in patients under general anesthesia can be challenging and requires a high level of suspicion.

Symptoms encompass nearly every organ system and can include: high fever, agitation, tachycardia, sweating, severe dehydration, peripheral edema, abdominal pain, nausea, vomiting, cardiac arrhythmia, cardiac failure, and pulmonary edema.

What Are the Causes of Thyroid Storm?

Most commonly, thyroid storm can result from: medication non-compliance, infection, trauma,

surgery, myocardial infarction, diabetic ketoacidosis, and pregnancy.

What Is Treatment for Thyroid Storm?

Treatment is generally supportive: initiation of cooling, aggressive IV fluid administration, and electrolyte repletion. Cardioversion may be necessary if arrhythmia is present. Invasive or noninvasive ventilation should be considered as suggested by arterial blood gas results.

An endocrinology specialist should be consulted to guide thyroid suppression treatment. For achieving thyroid suppression, one should consider the five ‘Bs’: Block synthesis (i.e., antithyroid drugs); Block release (i.e., iodine); Block T4 into T3 conversion (i.e., high-dose propylthiouracil, propranolol, corticosteroid; Beta-blocker); and Block enterohepatic circulation (i.e., cholestyramine).

Suggested Reading

Bajwa SJ, Sehgal V. Anesthesia and thyroid surgery: the never ending challenges. *Indian J Endocrinol Metab.* 2013;17(2):228–34. PMID: 23776893.

Carroll R, Matfin G. Endocrine and metabolic emergencies: thyroid

storm. *Ther Adv Endocrinol Metab.* 2010;1:139–45. PMID: 23148158.

Malhotra S, Sodhi V. Anaesthesia for thyroid and parathyroid surgery. *Cont Educ Anaesth Crit Care Pain.* 2007;7(2):55–8. <https://doi.org/10.1093/bjaceaccp/mkm006>.

Sinclair CF, Téllez MJ, Tapia OR, et al. A novel methodology for assessing laryngeal and vagus nerve integrity in patients under general anesthesia. *Clin Neurophysiol.* 2017;128(7):1399–405. PMID: 28395952.