

Anesthesia and thyroid surgery: The never ending challenges

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ABSTRACT

Thyroidectomy is the most common endocrine surgical procedure being carried out throughout the world. Besides, many patients who have deranged thyroid physiology, namely hyperthyroidism and hypothyroidism, have to undergo various elective and emergency surgical procedures at some stage of their life. The attending anesthesiologist has to face numerous daunting tasks while administering anesthesia to such patients. The challenging scenarios can be encountered at any stage, be it preoperative, intra-op or postoperative period. Preoperatively, deranged thyroid physiology warrants optimal preparation, while anticipated difficult airway due to enlarged thyroid gland further adds to the anesthetic challenges. Cardiac complications are equally challenging as also the presence of various co-morbidities which make the task of anesthesiologist extremely difficult. Thyroid storm can occur during intra-op and post-op period in inadequately prepared surgical patients. Postoperatively, numerous complications can develop that include hemorrhage, laryngeal edema, nerve palsies, tracheomalacia, hypocalcemic tetany, pneumothorax, etc., The present review aims at an in-depth analysis of potential risk factors and challenges during administration of anesthesia and possible complications in patients with thyroid disease.

Key words: Airway management, carbimazole, propranolol, thyroid, thyroidectomy, thyroxin, tracheomalacia

INTRODUCTION

Thyroidectomy is the commonest endocrine surgical procedure being carried out throughout the globe.^[1,2] Majority of these patients have deranged thyroid functions and sometimes may have even malignant changes in the thyroid gland.^[3] The commonest implications during such procedures involve the management of a potential difficult airway, especially in cases of retrosternal goiter, and an enlarged thyroid gland compressing over the trachea for a prolonged duration.^[4,5] Cardiac complications are equally challenging as also the presence of various co-morbidities which make the task of anesthesiologist extremely difficult. The complexity of surgical intervention also

adds to these existing challenges as the procedure may vary from simple excision of a thyroid nodule to removal of a large gland which may have a retrosternal extension.^[6] Moreover, there always exists a potential risk of uncontrolled hemorrhage from a vascular injury as the major vessels lie in the vicinity of thyroid gland and sometimes from the injury to the thyroid vessels itself.^[7] The present article is an attempt to review the disturbed endocrine milieu as a result of thyroid derangement that can have widespread systemic manifestations during thyroid surgery.

PRE-OP ASSESSMENT

The primary goal, in patients presenting for thyroid surgery, is to ensure a euthyroid state. Besides thyroid hormonal levels, huge emphasis is given to the assessment of any potential difficult airway management.

History

Elicitation of history should include symptoms related to hyperthyroidism, hypothyroidism and co-morbid medical diseases. A large-sized goiter present for a prolong duration

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makes the patient a potential candidate for developing tracheomalacia.^[8,9] History should also include any difficulties encountered during normal breathing and respiration such as dyspnea, orthopnea, dysphagia, stridor or breathlessness on assuming supine position. Specifically, such patients should be enquired about any endocrine disorder or symptoms related to autonomic nervous system dysfunction as there is a potential probability of having associated multiple endocrine neoplasia (MEN) syndrome.^[10] A rapid increase in the size of the goiter may be due to either hemorrhage or in rare cases due to rapidly enlarging malignancy that can cause airway management difficulty.^[11]

Clinical and physical examination

It involves a multidisciplinary approach as thyroid disease can be associated with various complexities. The active role of endocrinologist, surgeon, cardiologist, radiologist and anesthesiologist during pre-op examination warrants a closely coordinated team effort for precise diagnosis of the degree of thyroid derangement and other co-morbidities.

Signs of deranged thyroid function

The main focus during this period is on the presence or absence of signs related to thyroid dysfunction, namely hyperthyroidism and hypothyroidism [Table 1]. Equally significant is the presence of other co-morbid diseases such as cardio-respiratory and other associated endocrine disorders.^[7]

Signs of tracheal compression and vocal cords palsy

Examination of goiter should include the size, consistency, duration and extent of enlargement. Fixed and hardness of the gland points toward malignancy, while inability to feel the lower border of thyroid gland indicates retrosternal extension. The retrosternal extension of a large thyroid gland may cause superior venocaval obstruction syndrome, pleural and pericardial effusion and Horner's syndrome due to compression effect on the surrounding vital structures.^[4]

Airway evaluation

Airway examination should include assessment of neck movements in all planes (especially atlanto-axial flexion and extension), estimation of thyro-mental distance, any protruding incisors, protruding or retrognathic mandible and Mallampatti grading.^[5,12-14]

Investigations and lab findings

Routine investigations should include hemoglobin (Hb), white blood cell count, platelet count, serum electrolytes including serum calcium, thyroid function tests, renal function tests, chest X-ray, X-ray antero-posterior and lateral view of neck and ECG [Figure 1].

ENT examination

Indirect laryngoscopy should preferably be carried out by an ENT specialist as 3-5% of population invariably has unilateral paralysis of vocal cords.^[15] The presence of an ENT surgeon in the Operation Theater is also essential as there can be need for establishing a definite surgical airway during the induction period.

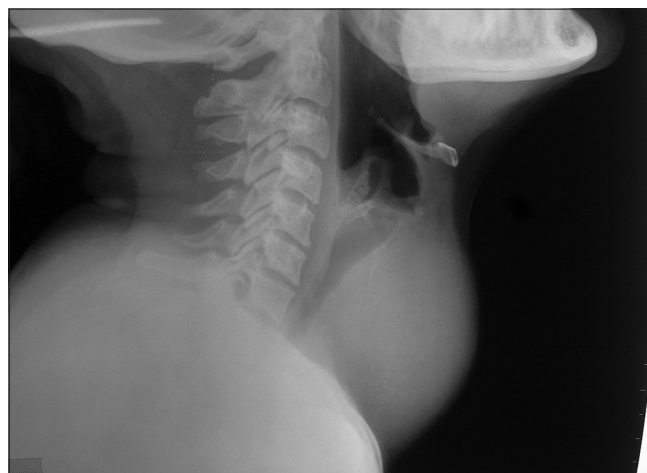


Figure 1: Lateral view of neck X-ray showing the compression of trachea from a longstanding enlarged goiter (thyroid gland)

Table 1: Clinical features of hyper-and hypothyroidism

Organ system (signs and symptoms)	Hyperthyroidism	Hypothyroidism
General	Weight loss	Weight gain, apathy, lethargy, fatigue
Gastrointestinal	Diarrhea, dehydration	Constipation, slow gastric emptying
Neurological	Nervousness	Slow mental functioning, bradykinesia, coma
Dermatological	Intolerance to heat, excessive sweating (warm moist skin)	Dry skin, thin eye brows, intolerance to cold, hair loss
Cardiovascular	Tachycardia, cardiac dysarrhythmias, mitral valve prolapse, heart failure	Bradycardia, cardiomegaly, heart failure, pericardial effusion
Musculoskeletal	Weakness of large group of muscles, osteoporosis	Muscle cramps
Hormonal	Menstrual abnormalities (most common is amenorrhea)	Menorrhagia, infertility
Metabolic	Increased serum alkaline phosphatase, hypercalcemia	Impaired clearance of free water, raised cholesterol
Ophthalmologic	Exophthalmos, proptosis, ophthalmoplegia, diplopia, optic nerve compression	Peri-orbital edema
Respiratory	Respiratory distress due to congestive cardiac failure	Dyspnea, orthopnea, depressed ventilatory responses to hypoxia/hypercarbia, pleural effusion
Hematological	Anemia, thrombocytopenia	Anemia

Radiological investigations

In case of a very large-sized thyroid gland and retrosternal extension, computed tomography (CT) scan or magnetic resonance imaging (MRI) is preferable to delineate the exact location and extension.^[6,16] The diagnosis of tracheal stenosis is possible with spiral CT scan.

Endocrinologist's and cardiologist's consultation

The pre-op examination by an endocrinologist and a cardiologist is of immense significance as minute but important findings can be missed by the surgeon, physician and the attending anesthesiologist, which can have significant impact on the surgical outcome. Though pulmonary function tests are not required in majority of cases, they can be useful adjuncts in cases of large thyroid gland or with retrosternal extension so as to elicit any fixed upper airway obstruction.

PRE-OP PREPARATION AND PREMEDICATION

Elective surgery

The main goal during any elective thyroid surgery is the pre-op optimization of thyroid functions and ensuring normal thyroid hormonal levels. Though propylthiouracil and methimazole have been used extensively, carbimazole is the drug of choice in preparing a hyperthyroid patient for the elective surgery.^[3] The increased vascularity of thyroid gland by carbimazole, however, exposes the patient to potential risks of higher bleeding during the surgical procedure. Also, decreased WBC count as a result of carbimazole therapy makes the patient vulnerable to numerous infections during post-op period. Previously, potassium iodide was also used to render the patient euthyroid, but this intervention takes a very long time, usually 4-6 weeks. Currently, β -blockers are extensively used as supplement to carbimazole to achieve cardiovascular stability.^[17] Failure to achieve these normal hormonal balances can lead to over administration of anesthetic agents as well as potential high risk of cardiovascular complications like atrial fibrillation, exaggerated hypertension and thyroid storm.^[18]

Patients with established hypothyroidism have decreased metabolic rate and a decreased capacity to metabolize the drugs which can prolong the recovery from the effects of anesthetic agents.^[19] Thyroxine is usually administered in a titrated manner to normalize the thyroid function as the pre-op higher levels of exogenous hormones can cause peri-op cardiac complications like ischemia and infarction due to imbalance between oxygen demand and supply ratio.^[20] The clinical manifestations of hypothyroidism which can have significant implications for an anesthesiologist include depressed myocardial function, impaired baroreceptor reflex mechanism, depressed ventilatory drive, decreased

plasma and RBC volume, hypoglycemia and impaired hepatic metabolism.^[18]

Myxoedema coma is a critical emergency situation which can be encountered in patients with profound hypothyroidism. It manifests clinically as a constellation of signs and symptoms which include, but are not limited to, severe lethargy, hypothermia, bradycardia and hypoxemia due to alveolar hypoventilation. The condition, if untreated, can deteriorate and progress to congestive heart failure and pericardial effusion. Emergency interventions sometimes do require intravenous administration of T3 and T4, but such interventions can precipitate congestive cardiac failure and myocardial ischemia. The supportive therapy in such emergency situations is mainly targeted to optimize and maintain individual organ system function.^[21]

Emergency surgery

In case of emergency surgical procedure, rapid preparation of the patient includes administration of β -blockers, corticosteroids, anti-thyroid drugs and iodine.^[17] The administration of β -blockers should be judicious in lieu of potential risk of congestive cardiac failure precipitation, bronchospasm in chronic obstructive pulmonary disease (COPD) patients and hypoglycemia in diabetic patients. Pre-op administration helps in tiding over any possible adrenal gland insufficiency.

Premedication is usually avoided in these patients because of potential difficult airway scenario and any possible respiratory obstruction. However, H-2 blockers like ranitidine and Oral sodium citrate solution are safe along with metoclopramide when administered preoperatively. A difficult airway trolley should be made ready and an ENT surgeon should be requested to scrub before induction of anesthesia.^[7]

Administration of anesthesia

The practice of superficial and deep cervical plexus blockade as well as cervical epidural anaesthesia are not recommended anymore as these techniques are invariably associated with potential risk of complications such as inadequate anesthesia or wearing of the effect of local anesthetics and cardio respiratory arrest.^[22,23] In the present day practice of anesthesiology bounded by medico-legal restrictions, general anesthesia with endotracheal intubation is the only safest approach for such delicate procedures.^[24-26]

The routine uses of glycopyrrolate and atropine as a part of premedication during thyroid surgery can be immensely helpful as it can dry up the secretions and also test the adequacy of anti-thyroid treatment. Pre-oxygenation with 100% oxygen enhances the functional residual volume

and thus can provide enough time for securing the access to difficult airway. Shorter acting opioids such as fentanyl, remifentanyl, sufentanyl should preferably be used but the limited availability of these drugs except fentanyl in our country is a major drawback. Currently, role of dexmedetomidine is increasingly acquiring significant dimensions in regional and general anaesthesia practice as it can greatly decrease the dose of opioids and anaesthetic agents when used as an adjuvant.^[27-29] Total intravenous anesthesia (TIVA) has become increasingly popular and all the thyroid procedures in our institute are carried out with this technique.^[27-29] Ever since its introduction into clinical practice, propofol has become an inseparable part of TIVA because of its excellent clinical characteristics and pharmacological actions such as rapid onset, rapid recovery and anti-emetic action.^[19] Propofol is the drug of choice in a dose of 2 mg/kg for induction of anesthesia. In a difficult airway scenario, succinylcholine remains the drug of choice, but ideally vecuronium is the preferred muscle relaxant because of its cardio-stability characteristics. The synergistic actions with opioids further widen the scope of propofol and fentanyl combination when used as a component of TIVA.^[30-32]

The nature of surgery warrants a free space around the patients' head end for a smoother procedure and free movement of the assistants. As such, there are chances that a simple PVC tube can get kinked under the drapes. Therefore, either an armored endotracheal tube (ETT) or Ring, Adair and Elwyn (RAE) tube (North Pole) is the preferred device for securing the airway as they have minimal chances of kinking and causing respiratory obstruction. Whichever ETT is used, it should be advanced beyond the point of extrinsic compression.

Airway management

Availability of fiberoptic bronchoscope eases the pressure to a large extent on the attending anesthesiologist. The relaxation caused by the anesthetic agents and muscle relaxants may lead to obstruction of the airway which can present with marked stridor initially during induction of anesthesia and inability to ventilate partially or completely with face mask after administration of general anesthesia. Such difficult scenarios can be encountered in malignancy of thyroid gland as it causes a lot of fibrosis and tethering of soft tissue structures, thereby making laryngoscopic view extremely difficult which emphasizes the role of fiberoptic bronchoscopy.^[12-14]

In difficult situations, laryngeal mask airway (LMA) can be used for ventilation, but for thyroid surgery, its utility is doubtful as there can be compression or deviation of trachea, retrosternal extension of goiter, abnormal vocal

cord movement and suspected malignancy which can pose difficulties in securing airway access.

Positioning

The surgical access warrants maximum exposure of thyroid gland which can be achieved by placing a padded ring under the head of the patient and a rolled sheet under the shoulders. The administration drugs necessitate an easy access to intravenous line which can be made possible with the use of extension tubing. All patients and especially those with hyperthyroidism having proptosis and exophthalmos should have their eyes covered with soft cotton pad. The gravitational drainage of the blood from the surgical site by a head-up position is a desirable feature and should be routinely practiced.

Monitoring

Monitoring during the perioperative period should be intense and vigilant as there are potential chances of hemodynamic and respiratory complications.^[33] Monitoring of temperature is also of utmost significance as there are potential risks of developing hyperthermia and hypothermia in hyperthyroid and hypothyroid patients, respectively, during the peri-op and post-op periods.

The prevention of stress response during extubation is widely appreciable as it can avoid any accidental hemorrhage from the wound site due to bucking movements from the trachea during reversal of anesthetic and muscle relaxant effects. Dexmedetomidine has a significant role in attenuation of stress response during these procedures.^[34] The main disadvantage in carrying out extubation in a deeper plane of anesthesia is the possible failure of elicitation of vocal cord movements. However, easy methods to detect such a complication include asking the patient to speak the letter "e" or the word "moon." There is a high incidence of hyperthyroid patients having associated myasthenia gravis, and as such neuromuscular blockade should be titrated and monitored with twitch monitor. Intra-op steroids are definitely helpful in prevention of airway edema and reduce the incidence of postoperative nausea and vomiting (PONV) as well.

POST-OP PAIN AND POSTOPERATIVE NAUSEA AND VOMITING

Numerous strategies can be employed for prevention of post-op pain and include peri-op administration of nonsteroidal anti-inflammatory drugs, superficial cervical plexus blockade, post-op infiltration of the wound site with local anesthetics and/or injectable form of short acting opioids postoperatively.^[35] These patients are known to have a high risk of developing PONV.^[36] Different anti-emetics such as metoclopramide,

dexamethasone, ondansetron, palonosetron, and so on can be used for prevention of PONV.^[37]

POST-OP COMPLICATIONS

Most of the dreaded events related to thyroid surgery are manifested in the post-op period,^[18] which include, but are not limited to, the following:

Hemorrhage

It is a common post-op complication and can cause compression over the neck structures, leading to acute airway obstruction. This is an acute emergency, and if it is not immediately possible to shift the patient to Operation Theater, then the sutures should be removed on the bedside to relieve the airway obstruction. In such difficult situations, the airway can be secured by easy-to-use devices such as LMA which can be used even by the paramedics as well if properly trained. If time permits and the anesthesiologist is available, definite airway in difficult situations can be secured even at the bedside by endotracheal intubation.

Laryngeal edema

It is frequently caused by multiple attempts at laryngoscopy during difficult intubation or due to venous obstruction of laryngeal vessels by an enlarging hematoma. If edema leads to stridor, intubation with ETT is mandatory.^[38]

RLN damage

Damage to RLN can be caused by traction, transaction, entrapment or ischemia and can be permanent or transient. Manifestations of unilateral RLN palsy during surgery include breathing difficulty, hoarseness of voice and difficulty in vocalization. Bilateral RLN palsy can lead to severe stridor as a result of complete adduction of vocal cords which can be treated only either by tracheal intubation or by tracheostomy.^[39,40]

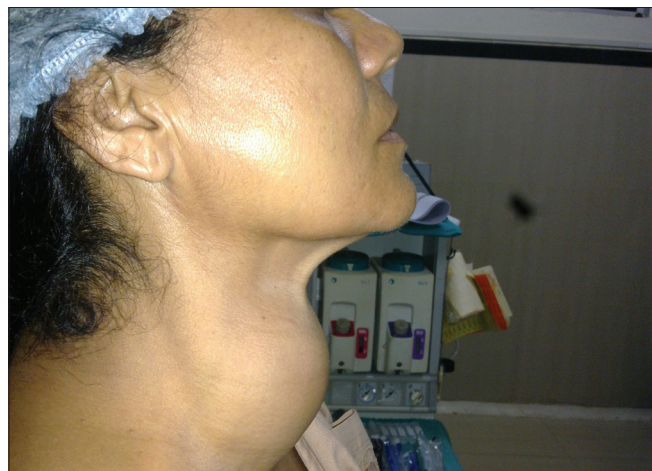


Figure 2: Lateral view of the neck showing the enlarged thyroid gland

Superior laryngeal nerve damage

Superior laryngeal nerve can get damaged in 3-5% of the thyroidectomy procedures and the commonest injury occurs to external branch of superior laryngeal nerve, resulting in the paralysis of cricothyroid muscle which causes alteration in the quality of voice as the vocal folds fail to tense during sound production. The injury can also occur to the internal branch of superior laryngeal nerve which provides sensory supply to mucosa of supraglottic region of larynx and superior surface of vocal folds. As a result, patient can develop dysphagia due to deranged swallowing reflex.

Tracheomalacia

A large-sized goiter compressing over the tracheal structures for a long duration can cause pressure atrophy and erosion of the cartilaginous tracheal rings [Figures 2 and 3]. Post procedure, the tracheal wall loses the surrounding support and can collapse in antero-posterior direction leading to respiratory obstruction. On occasions, the conditions necessitate re-intubation and possibly ventilatory support till the strength of tracheal wall returns as the condition itself is self-limiting. Some anesthesiologists feel that a cuff leak test before extubation can be a good indicator of possible post-op respiratory dynamics, but it has not been fully established in literature.^[8,9]

Hypoparathyroidism

One of the operative complications of thyroidectomy is injury to parathyroid glands or its accidental removal which can manifest in the form of acute hypocalcemia in approximately 20% of the patients. Features of hypocalcemia include peri-oral tingling, mental confusion, muscular twitching, seizures and tetany.^[41] Hypocalcemia can be elicited clinically by the presence of Chvostek's and/or Trousseau's sign. Cardiorespiratory manifestations



Figure 3: Frontal view of the neck showing enlarged thyroid gland (goiter)

of hypocalcemia can occur in the form of laryngospasm, cardiac irritability, prolongation of QT interval and varied arrhythmias. Hypocalcemia can be treated with oral supplements if the Ca⁺ levels are >2 mmol/l, but has to be treated with intravenous injection of either calcium gluconate or calcium chloride if the levels fall below 2 mmol/l. Calcium chloride is more effective as it contains three times more elemental calcium in a similar volume of injection.^[42]

Pneumothorax

Though this complication is rare, it can occur during the surgical resection of retrosternal goiter. On the operation table, any unwarranted episode of hypoxemia, fall of pulse oxygen saturation, hypotension, tachycardia, increased airway pressure, difficult ventilation and absence of breath sounds on ventilation should raise the suspicion of pneumothorax and should be timely diagnosed and managed accordingly. The best treatment at the earliest detection of this complication is either to relieve the pneumothorax by placing a wide-bored needle into second anterior intercostal space or to use a definite method, i.e. to go for insertion of chest tube if tension pneumothorax develops.

Thyroid storm

The commonest cause for this complication is either a severe illness or a poor preoperative preparation for thyroid surgery. Though rarely seen in the era of medical advancement, it can be fatal especially in the geriatric population if the treatment is even slightly delayed. The main etiology is the hyperactive thyroid tissue which is left as a remnant after sub-total thyroidectomy. It can also occur during the intra-op period as a result of secretion of colloid from the follicular cells, which can be suspected from unexplained tachycardia, hyperthermia and arrhythmias. The classical features of thyroid storm such as abdominal pain, diarrhea, nervousness and restlessness cannot be elicited and only hyperthermia and cardiac arrhythmias can be seen under general anesthesia. Treatment consists of emergency management of tachycardia with β -blockers, cooling of the body by decreasing the ambient room temperature, infusion of cold fluids and draping in ice-cold packs, and administration of steroids. Propylthiouracil and methimazole are used in fairly high doses to decrease the thyroid hormone synthesis.

CONCLUSIONS

The perioperative morbidity in patients with thyroid disease can be greatly reduced by proper preoperative preparation and optimization of physiological status of thyroid. Airway management in such patients poses unique challenges and one should be thoroughly prepared for any anticipated or unpredictable airway difficulty. Postoperatively, any

incidence of hemorrhage leading to formation of hematoma can cause respiratory obstruction. Extreme vigilance has to be exercised both by the surgeons and anesthesiologist for a possible incidence of any nerve injuries and palsies, hypothermia, tracheal collapse and tracheomalacia as well as hypocalcemia and should be managed accordingly. Both during elective and emergency surgery, the cardiovascular system have to be meticulously examined as it bears the maximum brunt of deranged thyroid functional status.

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