Anaesthesia for thyroid surgery: Perioperative management

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Abstract

The aim of this review is to analyse anaesthesiologic preoperative assessment, intraoperative management and postoperative complications of patients with thyroid disease. A special care is paid to difficult airway recognition and resolving this situation. Anaesthetist’s and surgeon’s point of view of perioperative and postoperative complications is both discussed with special interest on early surgical complications and the need for urgent anaesthetic treatment. Particularly total intravenous anaesthesia and recurrent laryngeal nerve monitoring actually are two end-points in the thyroid surgery.

1. Introduction

Thyroid diseases which have anaesthetic implications include hypothyroidism, hyperthyroidism and conditions requiring thyroidectomy. Anaesthesia for thyroidectomy may be complicated by airway problems such as retrosternal extension of the gland. The anaesthetist should therefore pay particular care to preoperative airways' assessment and should be able to deal with acute airway complications in the perioperative phase.

2. Preoperative assessment

Identification of abnormalities of thyroid function is due to schedule patients: symptoms and signs of hypo- and hyperthyroidism and evidences of other medical conditions should be sought, particularly cardiorespiratory diseases and associated endocrine disorders. Routine investigations include thyroid function tests, haemoglobin, white cell and platelet count, urea and electrolytes, including serum calcium, chest X-ray and indirect laryngoscopy in order to document any preoperative vocal cord dysfunction. Seeking for some evidence of tracheal compression and deviation a lateral thoracic X-ray is requested instead the only antero-posterior one to show tracheal compression. Other non-routine investigations are useful to value certain cases: computerised tomography (CT) can provide excellent views of retrosternal goitres and magnetic resonance imaging (MRI) has the advantage to provide images in the sagittal and coronal planes as well as transverse views (Figs. 1 and 2). Preoperative airway evaluation using new multislice 3D CT and high-resolution virtual laryngoscopy based on spiral CT data for patients with severe tracheal stenosis is useful. 3D figures of the trachea and a virtual bronchoscopic movie can be obtained from multislice CT scanning to evaluate the stenotic region and to simulate the virtual movie fibroscopic tracheal intubations. Anaesthesia’s choice will be modulated by therecoming’s data.

2.1. Retrosternal goitre

Although some retrosternal goitres are large the vast majority can be removed by the cervical route. The surgeon’s manipulation worsens the retrosternal gland by compressing the trachea. Thyroid surgery also occasionally requires mediastinal exploration so that it should be better the endocrine theatre team to perform a sternotomy. Longstanding goitre may perform tracheal deviation and compression which suggest tracheomalacia. Anaesthesia for retrosternal goitre provides a challenge to the anaesthetist during establishment of airway and the incidence of complications can be greatly reduced by adequate preoperative assessment and planning.

3. Thyroid disease and anaesthetic implication

3.1. Hyperthyroidism

Hyperthyroidism results from excessive tissue and circulating concentrations of thyroid hormones. Clinical manifestations
suggest increased sensitivity to circulating catecholamines although measured catecholamine levels are within normal limits.

### 3.1. Perioperative considerations

- Determine if hyperthyroidism is under control looking for signs and symptoms of a hypermetabolic state, reviewing thyroid function tests, other pertinent studies, medications and treatment’s duration. Propylthiouracil and methimazole are the preferred drugs for preoperative preparation but it takes weeks to render a patient euthyroid. Iodine is often added to thionamide treatment. Beta-blockers reduce heart rate and provide symptomatic relief as well as cardiac protection but do not affect thyroxine production or iodine metabolism and do not prevent thyroid storm.

- Only emergent procedures preclude waiting for a euthyroid state! Rapid preparation may be required: administer a combination of beta-blocker, corticosteroid, thionamide, iodine, and iopanoic acid.

- Be aware that overzealous beta-blockade could precipitate congestive heart failure, bronchospasm and hypoglycaemia in diabetics. Consider corticosteroids because adrenal reserves may be low. A strict monitoring is due to evidence cardiovascular impairment.

### 3.2. Hypothyroidism

Hypothyroidism may result in depression of myocardial function, decreased spontaneous ventilation, abnormal baroreceptor function, reduced plasma volume, anaemia, hypoglycaemia, hyponatraemia and impaired hepatic drug metabolism.

#### 3.2.1. Perioperative considerations

- The combination of intravenous T3 and T4 is recommended for preoperative myxoedematous coma management to make the patient euthyroid.

- If possible avoid premedication and use regional anaesthesia. T4 may be omitted in the morning of surgery but it is advisable to give the patient’s usual morning dose of T3.

- Preventive measures should be adopted to protect against hypothermia. Hypothyroid patients should receive hydrocortisone cover during increasing surgical stress.

### 3.3. Thyroid crisis

Thyroid crisis still occurs in uncontrolled hyperthyroid patients as a result of a trigger such as surgery, infection or trauma. Supportive management includes hydration, cooling, inotropes and formerly steroids. Beta-blockade by labetalol or esmolol and antithyroid drugs is the first-line treatment. An acute thyroid crisis at induction of anaesthesia, which was mistakenly diagnosed as malignant hyperthermia, was successfully treated by boluses of dantrolene 1 mg kg⁻¹. Thyroid hormones sensitise the adrenergic receptors to endogenous catecholamines therefore magnesium sulphate seems to be a useful drug by reducing the incidence and severity of dysrhythmias caused by catecholamines.

### 4. Anaesthetic technique

#### 4.1. Regional anaesthesia

It is possible to perform thyroidectomy under bilateral deep and/or superficial cervical plexus blocks. Our opinion with bilateral deep cervical plexus block suggests that it is a dangerous technique concerning its serious complications. Regional (local) anaesthesia is a useful alternative for particular circumstances, e.g. video-assisted thyroidectomy (VAT) performed under superficial cervical plexus block (mono or bilateral). Cervical epidural anaesthesia is another technique particularly useful if respiratory problems. Close monitoring of haemodynamics, respiratory rate and level blockade is required.

#### 4.2. General anaesthesia

General anaesthesia with tracheal intubation and muscle relaxation is the most popular anaesthetic technique for thyroidectomy. It is wise to select a small-reinforced tracheal tube if there is some degree of tracheal compression. Intravenous anaesthesia and total intravenous anaesthesia (TIVA) become...
wider in modern anaesthetic techniques in thyroid surgery. Several intravenous hypnotics and analgesics are currently used for the induction and maintenance of general anaesthesia: propofol and alfentanil have the most suitable pharmacokinetic and pharmacodynamic profiles for administration by continuous infusion. Propofol is the best suited intravenous agent for maintenance of anaesthesia, as it provides a rapid onset of anaesthesia, by its short equilibration half-times (T1/2 Ke0) and rapid recovery, as shown by its short context-sensitive half-times. In addition propofol has several advantages over volatile anaesthetics such as a very low incidence of postoperative nausea and vomiting and it could be safely used in patients susceptible to malignant hyperthermia. Propofol and opioids in general as well as propofol and alfentanil potentiate one another when given perioperatively. A similar behaviour in drug interaction can be seen when propofol is combined with remifentanil, the youngest opioid, which is characterised – in contrast to alfentanil – by an extremely short duration of action and which allows furthermore a rapid and predictable response to alterations in dose.9,10

5. Difficult tracheal intubation in thyroid surgery

The anaesthetist should expect that 6% of tracheal intubations for thyroid surgery will be difficult. The evaluation factors linked to difficult endotracheal intubation (DEI) is limited to a few studies. In the study of Bouaggad11 with multivariate analysis, two criteria were recognised as independent for DEI (Cormack Grade III or IV and cancerous goitre) and it concludes that a large goitre is not associated with a more frequent DEI. However, the presence of a cancerous goitre is a major factor predicting DEI caused by tracheal invasion and tissue infiltration by the carcinoma associated with fibrosis which may reduce the mobility of laryngeal structures and make the laryngoscopic view more difficult. Whenever supposing that the airway will be lost if anaesthesia is induced, awake fibreoptic intubation is the method of choice.

6. Intraoperative neuromonitoring

The incidence of temporary unilateral vocal cord paralysis resulting from damage to the recurrent laryngeal nerve (RLN) is 3–4%. Permanent unilateral vocal cord paralysis occurs in <1% of patients and bilateral vocal cord paralysis should be extremely rare. Injury to the recurrent laryngeal nerve may occur by several mechanisms including ischaemia, contusion, traction, entrapment and actual transection. There is a greater risk of nerve damage during surgery for malignancy and reintervention. Attempts to protect the recurrent laryngeal nerve during thyroidectomy involve detecting vocal cord movement after nerve’s stimulation. Intraoperative electro-physiological monitoring concerns the use of a tracheal tube with integrated EMG electrodes positioned at the level of the vocal cords. When the RLN has been identified, the nerve is stimulated until an evoked EMG is obtained. In addition to the atraumatic dissection of the RLN, intraoperative neuromonitoring has become accepted practice during surgery in this area. A quantitative neurophysiological evaluation of the RLN is based on the recording of evoked potential at the vocalis muscle. Thus neuromuscular blockade may interfere with intraoperative neuromonitoring of the RLN. In the study of Marush et al. the influence of muscle relaxation on neuromonitoring of the recurrent laryngeal nerve was investigated. The main findings were that neuromonitoring of the RLN is applicable despite muscle relaxation <90% and that the laryngeal muscles exhibited a shorter response time than the adductor pollicis and quickly recovered.12

7. Postoperative complications

7.1. Haematoma

Postoperative haemorrhage is potentially catastrophic when someone is operating on the neck but it could be avoided by fair haemostasis. The anaesthetist may be asked to maintain the patient’s intrathoracic pressure positive for 10–20 s in order to assess haemostasis before wound closure.13 Clip removers usually were kept at the bedside to enable rapid relief of a haematoma. Fast decision-making is important and early re-intubation is recommended. The later intubation is obviously performed the more difficult it becomes as the haematoma expands and compresses the airway.

Respiratory obstruction may be caused by laryngeal and pharyngeal oedema as a result of venous and lymphatic obstruction by the haematoma rather than direct tracheal compression.

7.2. Tracheomalacia

Tracheal collapse following thyroidectomy results from prolonged compression of the trachea by a large, neglected goitre, particularly within the confines of the thoracic inlet.14 It is a life-threatening complication,15 which should be considered before extubation, and management strategies should be available. Management of tracheomalacia requires urgent re-intubation, possibly tracheostomy and some forms of tracheal support such as ceramic rings.

7.3. Laryngeal oedema

Laryngeal complications of tracheal intubation can be seen during the postoperative indirect laryngoscopy which is performed to identify recurrent laryngeal nerve damage. Oedema and traumatic lesions were noted in 4.6% of patients.16 While trauma to the larynx from the tracheal tube will cause minor swelling, laryngeal oedema is a rare cause of post-thyroidectomy respiratory obstruction.

7.4. Hypocalcaemia

After thyroidectomy for large multinodular goitre the incidence of temporary hypocalcaemia occurs in 20% of patients about 36 h postoperatively. This might be reduced by more careful inspection of the thyroid capsule.17

7.5. Postoperative nausea and vomiting

Patients undergoing thyroidectomy are at high risk for the development of postoperative nausea and vomiting (PONV). Combination antiemetic therapy with granisetron plus droperidol or granisetron plus dexamethasone is highly effective in preventing PONV.18

7.6. Postoperative pain

Patients usually tolerate thyroidectomy very well and require minimal postoperative analgesia. They often complain of a stiff neck because of the position during surgery rather than pain from the site of the incision. Concerning these considerations it is successful to combine NSAIDs and acetaminophene. We
recommend while performing TIVA the adoption of postoperative pain protocols to be started within the intervention.

8. Conclusion

Anaesthesia for thyroid surgery requires an anaesthetist who is experienced in the recognition, assessment and management of a potentially difficult, shared airway, in a patient who may also have significant co-morbidity. We believe that TIVA is the first choice technique for thyroid surgery in order of its fast and gentle recovery from anaesthesia and concerning the lower incidence of postoperative nausea and vomiting. Neuromonitoring during thyroidectomy is effective in providing identification and function of laryngeal nerves. The anaesthetist is strictly involved in this technique being responsible of the right positioning of the endotracheal tube and the management of the neuromuscular blockade.

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References
Anaesthesia for thyroid and parathyroid surgery

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Thyroid disease has been long recognized: goitres were first described by the Chinese in 2700 BC. Thyroid surgery was first described in the 12th Century, but for many years the operations were so prone to complications that it prompted Samuel Gross to write in 1848:

‘Can the thyroid in the state of enlargement be removed? Emphatically experience answers no...every stroke of the knife will be followed by a torrent of blood and lucky...if his victims lived long enough for him to finish his horrid butchery. No honest and sensible surgeon would ever engage in it’.1

In the UK, Stanley Rowbotham pioneered anaesthesia for thyroid surgery in the 1940s. He combined local anaesthesia with light general anaesthesia, and even attempted to make the patient strain to test haemostatic sutures using one breath of ether.1

Anaesthesia for thyroid surgery requires an anaesthetist who is experienced in the recognition, assessment, and management of a potentially difficult, shared airway, in a patient who may also have significant co-morbidity.

Complexity of the procedure may vary from excision of a simple nodule to removal of retrosternal goitre to relieve tracheal compression. The latter can be excised through a standard collar incision, but it may be necessary to split the sternum to access the inferior pole of the enlarged gland. Although blood loss is usually minimal, there is potential for major haemorrhage from large blood vessels closely related to the gland, particularly if the thyroid extends retrosternally.

Preoperative assessment

History

The duration of the goitre is important. Long-standing compression of the trachea may be associated with tracheomalacia. A rapid increase in size suggests the possibility of malignancy. Symptoms of positional breathlessness, dysphagia, stridor, and voice change should be elicited. These give an indication of the extent of the goitre and possible problems in lying the patient flat for induction of anaesthesia.

Examination

The patient should be clinically euthyroid before surgery. Tachycardia and atrial fibrillation should be excluded by assessment of the resting pulse. Routine assessments of the airway should be done (e.g. Mallampati score, mandible protrusion, Patil’s test) and the neck should be examined to assess the size of the goitre and its consistency; a hard goitre suggests malignancy. If it is possible to feel below the gland, then retrosternal spread is unlikely. It is also important to check for tracheal deviation, listen for stridor, and to assess the range of movement of the neck. Infiltrating carcinomas may make neck movement, and hence intubation, difficult.2

Superior vena caval (SVC) obstruction is indicated by the presence of distended neck veins that do not change with respiration. Pemberton’s sign of SVC obstruction may be elicited by asking the patient to raise his arms straight up; if obstruction is present, the patient’s face will become blue and engorged.

Investigations

Blood tests: A full blood count, electrolytes, thyroid function, and corrected calcium levels should all be routinely performed.

Chest X-ray: This may show tracheal deviation and narrowing. In complex or suspicious cases, lateral thoracic inlet views may be necessary to exclude retrosternal extension and to detect tracheal compression in the anteroposterior plane.
**Anaesthetic techniques**

Several methods, including combinations of techniques, can be used safely and effectively.

**Regional anaesthesia**

In the UK, thyroidectomy is not routinely performed under regional anaesthesia. However, this has been shown to be safe and successful in a selected group of patients, resulting in low morbidity and high levels of patient satisfaction. Anaesthesia is achieved using deep and superficial cervical plexus blocks, with or without sedation. Patients who cannot communicate verbally with the surgical and anaesthetic team, or who are obese, are unlikely to be good candidates for this technique.

**General anaesthesia**

The majority of cases are straightforward even when imaging suggests significant degrees of tracheal deviation or compression. Full preoxygenation should precede i.v. induction and muscle relaxation with a neuromuscular blocking drug, once manual ventilation has been demonstrated. If preoperative assessment has increased concerns regarding the airway, the following options should be considered:

1. Induction in the semi-supine or sitting position.
2. Inhalation induction with sevoflurane: the patient should be premedicated to dry secretions, and airway adjuncts such as a nasopharyngeal airway of correct size should be immediately available in case the patient obstructs their airway as they lose consciousness. Sevoflurane in Heliox may be useful in cases when preoperative assessment has increased concerns regarding the airway.
3. Tracheostomy under local anaesthetic may be performed by the surgeon.
4. Tracheostomy under local anaesthetic may be performed by the surgeon.
5. Ventilation through a rigid bronchoscope can be performed if attempts to pass an endotracheal tube (ETT) fail because of a mid-lower tracheal obstruction.

Whichever approach is used, all equipment must be checked and the surgeon must be immediately available.

Anaesthesia may be maintained via inhalation agents or i.v. anaesthesia. The use of remifentanil for thyroid surgery has become increasingly popular. Remifentanil provides analgesia intraoperatively, and also contributes to the hypotensive anaesthetic required to provide a bloodless surgical field; it also obviates laryngeal reflexes, so reducing the need for further doses of muscle relaxant.

**Other perioperative considerations**

The patient should be recovered sitting upright as much as possible to avoid venous congestion and oedema. A superficial cervical plexus block can be useful for postoperative analgesia. Many surgeons infiltrate s.c. with local anaesthetic and epinephrine before incision. This will reduce the requirement for opioid analgesia in the recovery phase, and most patients will remain comfortable with regular paracetamol and NSAIDs after operation.

**Postoperative complications**

**Haemorrhage:** This may result in tense swelling in the neck and respiratory difficulty. Clip removers or stitch cutters must be kept at the bedside to evacuate blood and haematoma, if the patient is...
If the serum calcium is 2 mmol litre$^{-1}$, oral calcium supplements are prescribed. If the serum calcium is below this concentration, urgent treatment should be commenced with i.v. calcium (usually 10 ml of 10% calcium gluconate for more than 3 min). A calcium infusion may be necessary.

Pneumothorax: This is a possible complication of retrosternal dissection.

Parathyroid surgery

The four parathyroid glands are responsible for maintaining calcium homeostasis via secretion of parathyroid hormone. Parathyroid hormone acts on the bones and kidneys to increase serum calcium and decrease serum phosphate. It stimulates osteoclasts to release calcium and phosphate into the extracellular fluid, and simultaneously increases phosphate excretion and calcium re-absorption in the kidney.

The commonest indication for surgery is primary hyperparathyroidism (PHP) from a parathyroid adenoma. The incidence of PHP is thought to be 25 per 100 000 of the UK population, and as high as 1 in 500 of women over the age of 45 years. An increased circulating parathyroid hormone concentrations causes hypercalcaemia that leads to fatigue and bone, abdominal, urological, and mental symptoms. Thus, PHP was described historically as a disease of ‘stones, bones, abdominal groans, and psychic moans’. PHP is also associated with a higher incidence of cardiovascular deaths related to hypercalcaemia, impaired glucose tolerance, increased fracture risk, and poorer quality of life scores than the normal population.

Minimally invasive parathyroidectomy

More than 80% of patients with PHP have a solitary adenoma, removal of which guarantees cure. The lack of a consistently reliable method for localizing parathyroid tumours hampered the introduction of minimal access approaches to parathyroid disease. For example, ultrasonography of the neck is operator dependent, whereas thallium–technetium subtraction scintigraphy is dependent on the size of the adenoma. Technetium-99 m sestamibi scanning has revolutionized preoperative localization of parathyroid glands, as it accurately identifies the size and site of the tumour in 88% of patients. Subsequently, a minimal access approach may be adopted, which is most commonly achieved through a 2-cm skin incision placed over the appropriately localized parathyroid gland.

Anaesthesia

Although general anaesthesia is still common, using either a reinforced tracheal tube or a laryngeal mask airway, this procedure is increasingly carried out with local anaesthesia, which may be particularly suitable for the patient with marked cardiorespiratory disease. Local anaesthesia may involve cervical nerve blocks or surgical infiltration with or without sedation.

Cervical nerve blocks may be deep, superficial, or both. The deep cervical block is technically more challenging and has significant risks, including inadvertent injection into the dural cuff or vertebral artery and phrenic nerve palsy. For this reason, it is generally advised that bilateral deep cervical blocks should be avoided. When patients anaesthetized with superficial cervical block alone were compared with patients having combined superficial and deep blocks for parathyroidectomy, there was no difference between the groups regarding requirement for supplementary analgesia, patient satisfaction, pain scores, or postoperative analgesia requirements, except that the combined group requested analgesia earlier. Whichever technique is used, it is generally accepted...
that supplementation is required to the upper poles of the thyroid to allow retraction.

Surgical infiltration may be supplemented with sedation. In the authors’ unit, this is effectively achieved using a combination of midazolam and remifentanil, or alfentanil.

**Postoperative care**

Serum calcium should be checked at 6 and 24 h after operation. Hypocalcaemia, as discussed above, requires supplementation; persisting hypercalcaemia is rare. Pain is not usually severe and easily controlled with oral analgesia, although NSAIDs should be avoided in patients with renal compromise.

**References**


Please see multiple choice questions 22–25
Surgery of Parathyroid

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Abstract Surgery of parathyroid revolves around the management of hyperparathyroidism (HPT). In most cases, occurrence is sporadic rather than familial, and 80–85% of cases of sporadic primary HPT are caused by a solitary parathyroid adenoma. The diagnosis is made by hypercalcaemia with an inappropriately elevated parathyroid hormone (PTH) level and a 24-hour urine calcium excretion level that is normal or high. Improved assay for PTH has led to earlier detection of HPT and has been responsible for the apparent increase in the prevalence of the disorder. An improvement in preoperative localisation studies as well as the development of a rapid intraoperative PTH assay has changed the approach to parathyroid surgery in the last two decades. This article provides a brief overview of management of primary HPT.

Keywords Primary hyperparathyroidism · Hypercalcaemia · Sestamibi scan · Parathyroidectomy

History

The parathyroid glands were first identified in 1850 in an Indian Rhinoceros in a London zoo by Richard Owen, then Professor of Anatomy at the Hunterian Museum of the Royal College of Surgeons of England [1]. His work published in 1862 went unnoticed for several years. Credit for the recognition of the parathyroid glands in humans went to Ivar Sandstrom a medical student at Uppsala University in Sweden who named them “glandulae parathyroidae”. The first parathyroidectomy for primary HPT was performed by Mandl in 1925 [2].

Surgical anatomy and physiological aspects

A thorough understanding of the anatomy of parathyroid glands is essential before embarking on parathyroid exploration. The parathyroid glands usually four in number arise from the endoderm of the third and fourth pharyngeal pouches. The superior parathyroids arise from the fourth pharyngeal pouch and are usually present superior to the inferior thyroid artery and dorsal to the recurrent laryngeal nerve. The inferior parathyroid glands arise from the third pharyngeal pouch and are usually present superior to the inferior thyroid artery and dorsal to the recurrent laryngeal nerve. The inferior parathyroid glands arise from the third pharyngeal pouch and descend with the thymus into the lower part of the neck [3]. Due to this longer migration, they may be found at any position in the neck and the mediastinum, although the majority lie within 1–2 cm of the lower pole of the thyroid gland. The inferior parathyroids usually lie inferior to the inferior thyroid artery and ventral to the recurrent laryngeal nerve. Although most people have four parathyroid glands, a range from 2 to 6 have been described.

Parathyroid hormone (PTH) is an intact 84 amino acid peptide with amino and carboxyl terminals that is secreted in response to a fall in plasma ionised calcium concentration. The circulating PTH which has a half-life of
about 5 minutes in patients with normal renal function, is initially cleaved in the liver, yielding an inactive C-terminal fragment, which is ultimately cleared by the kidney [4]. The N-terminal fragment is the part of the peptide that is responsible for the biological activity of PTH on peripheral tissues. PTH interacts with vitamin D and its metabolites in regulating calcium absorption and secretion. PTH has direct effects that promote reabsorption of calcium from renal tubules and bone. PTH has indirect effects, mediated by increasing renal conversion of 25-hydroxycholecalciferol to more potent hormone 1,25 dihydroxycholecalciferol which results in increased calcium absorption from food.

The surgery of parathyroids revolves around the management of primary HPT and hence the management of primary HPT is discussed in detail below.

Primary hyperparathyroidism

Primary HPT is the detection of hypercalcaemia in the presence of inappropriately elevated circulating PTH levels. Primary HPT is the most common cause of hypercalcaemia in unselected non-hospitalised patients. It is the second most common cause of hypercalcaemia (after malignancy) in hospitalised patients.

The exact cause of sporadic primary HPT is unknown and is likely multifactorial, with environmental and genetic causes. It is associated with a history of radiation exposure [5, 6] as well as with prolonged lithium use [7, 8]. Genetic associations in sporadic primary HPT include over expression of the PRAD1 oncogene (encoding cyclin D1) and an inactivating mutation of the multiple endocrine neoplasia type 1 (MEN1) tumour-suppressor gene (encoding menin) [9]. The MEN1 gene is also associated with familial HPT, as are RET (associated with MEN2), HRPT2 (encoding parafibromin, associated with HPT-jaw tumour syndrome), and the CASR gene (encoding the calcium-sensing receptor, associated with neonatal primary HPT).

Incidence

There is, however, a higher prevalence with increasing age, especially in females. In the age group below 40, the incidence of HPT is about 10 cases per 100,000 populations. In those over the age of 60 years, there is a steep rise in incidence to about 91/100,000 in men and 188/100,000 in women. The incidence is highest in the third to fifth decade.

Pathology

Primary HPT may be sporadic or familial. In most cases (80–85%), sporadic primary HPT is caused by a solitary parathyroid adenoma, with the remainder of cases due to double adenomas (about 4%), multiple-gland hyperplasia (10–15%) and parathyroid carcinoma (<1%). Familial syndromes associated with primary HPT include MEN1 and MEN2, non-MEN, familial HPT, HPT-jaw tumour syndrome, and familial neonatal HPT. These familial syndromes are associated with (usually asymmetric) multiple-gland hyperplasia. In addition, non-MEN familial HPT and HPT-jaw tumour syndrome are associated with an increased risk of parathyroid cancer.

Hyperplasia of all four parathyroids is typical of secondary HPT. However, hyperplasia is responsible for the primary disease in about 10% of cases and may affect two or more glands. The chief cells are frequently involved. In contrast to an adenomatous gland, the hyperplastic parathyroid shows no rim of normal tissue and the overall appearance is uniform. Nodular hyperplasia is a feature strongly associated with MEN syndrome.

Carcinoma parathyroid is a rare cause of HPT accounting for <2% of all cases of primary HPT. Most cases occur in the fourth to sixth decade of life and in contrast to the female predominance observed for adenomas, there are no sex differences in the incidence of carcinomas [10]. A visible and palpable lump in the thyroid region along with hypercalcaemia should alert the surgeon to the possibility of diagnosis of carcinoma of the parathyroid. The definitive diagnosis is only made postoperatively from histopathology. Typically, the carcinoma is firm to hard, grey in colour and adherent to the adjacent tissue. The distant metastases to the liver and bone is a late feature and indicate terminal disease.

Clinical features

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<tr>
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<th>Nephrolithiasis/renal failure</th>
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<td>Anorexia</td>
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<td>Polyuria/nocturia</td>
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Diagnosis of primary HPT

- **Increase in serum calcium**
- **Increase in PTH**. There is an inappropriate increase in serum calcium with relation to serum PTH.
- **Twenty-four hours urinary calcium** is done to exclude familial hypocalciuriic HPT (FHH). In patients with FHH, there is a mutation in extracellular calcium sensor. This causes increased renal tubular reabsorption of calcium, which results in urinary calcium levels <150 mg/24 hours. The most accurate way to diagnose FHH
is by calculating the calcium-to-creatinine clearance ratio. It is extremely important to identify patients with FHH because they remain asymptomatic throughout life and therefore, do not require any surgical intervention. A urinary calcium excretion of 400 mg/24 hours or higher is generally considered an indication for surgical exploration.

Normocalcaemia does not exclude HPT. Complementary tests that support the diagnosis and identify patients who have associated deleterious effects of HPT are as follows.

- **Plasma phosphate**: As more phosphate is lost in urine, serum phosphate levels falls.
- **Plasma creatinine**: Indicates renal function.
- **Alkaline phosphatase**: Indicator of bone disease.
- **Chloride**: Phosphate ratio of >33 indicative of primary HPT

**Normocalcaemic hyperparathyroidism**

There is a small subset of patients with primary HPT who present with normal or intermittently elevated calcium levels. The exact biochemical mechanisms of normocalcaemic primary HPT remain unknown. It has been postulated by some that normocalcaemic variant of primary HPT represents an early or preclinical phase that progresses to typical hypercalcaemic primary HPT [11, 12]. The majority of patients with normocalcemic primary HPT present with renal calculi and hypercalciuria.

**Surgical intervention**

Primary HPT is essentially a surgical disease. Surgery achieves normocalcaemia in about 95% of cases. Surgery is indicated in all patients with symptomatic primary HPT and in acute primary HPT (parathyroid crisis). Patients with primary HPT presenting with osteitis fibrosa cystica (brown tumour) are nowadays uncommon (Figs 1 and 2). A change in clinical profile and better diagnostic assays have resulted in more cases of asymptomatic HPT. There has been a paradigm shift in the threshold for surgical intervention in asymptomatic patients. In 1990, the National Institutes of Health (NIH) convened a consensus conference on the management of asymptomatic primary HPT [13]. These guidelines were then revised in 2002, at the workshop on asymptomatic primary HPT [14].

What are the indications for surgery in patients with asymptomatic HPT?

- Serum calcium >1.0 mg/dl (0.25 mM) above the reference range

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Fig. 1 X-ray showing Brown tumour of tibia and skin clips indicating biopsy site

Fig. 2 X-ray pelvis showing left haemipelvectomy for “giant cell tumour of ilium” in a patient who was later discovered to have a parathyroid carcinoma

- Twenty-four hours urinary calcium excretion >400 mg (10 mmol)
- Creatinine clearance reduced by 30% compared with age-matched control subjects
- Forearm, lumbar spine, or hip T score reduced by >2.5 SD on bone mineral density scan
Patients younger than age 50 years
Patients for whom medical surveillance is either not desirable or possible.

Preoperative localisation

The rationale for locating the abnormal parathyroid before surgery is that the glands can be notoriously unpredictable in their location. An experienced surgeon should be able to locate the parathyroid in about 95% of cases. However at times the localisation of parathyroid becomes difficult especially when the patient has had previous neck surgery, or in ectopic positions of parathyroids. Although ultrasound scan of the neck, CT scan and MRI scan and selective venous sampling have been used, the localising test of choice is Technetium-99m (99mTc) sestamibi scan (Fig. 3). Thallium – Technetium which was widely used previously has now been largely replaced by sestamibi scan. The fortuitous discovery by Coakley et al. [15] that 99mTc sestamibi concentrates in abnormal parathyroid glands has revolutionised the practice of parathyroid surgery.

Sestamibi is an isonitrile compound, which is labeled with 99mTc to form a cationic complex. Sestamibi accumulates in the mitochondria of cells and therefore a tissue with large number of mitochondria may take up sestamibi more avidly. It has been shown that parathyroid adenomas have a large number of mitochondria in their cells and it is therefore possible that it would be taken up more avidly in adenomatous tissue than the surrounding thyroid and following uptake a slower release would occur from the parathyroid cell. Despite the high sensitivity rate for parathyroid disorders especially parathyroid adenomas, an important limitation of this technique is false positive findings. The common cause of false positive are multinodular goitre, hashimotos thyroiditis, thyroid adenomas and thyroid carcinoma. Sestamibi scan is now considered mandatory before operative intervention in persistent or recurrent HPT.

Bilateral neck exploration

The surgical gold standard is a bilateral neck exploration with identification of all four parathyroid glands and resection of the abnormal gland(s). This procedure has a success rate of about 95–98% for curing primary HPT, with minimal morbidity, mortality close to zero and excellent cosmetic results [16].

Exposure and technique of exploration

Incision and exposure is similar to that of thyroid surgery. Meticulous haemostasis is crucial. The middle thyroid vein should be divided to allow full mobilisation of thyroid lobe to search for parathyroids. If need be, the fascia on the posteromedial aspect of thyroid is incised to increase the area of exposure. Upper parathyroids are located within 2 cm radius of the site of division of inferior thyroid artery. The inferior gland is less constant in position. It is found in 80% of cases within 2 cm radius of inferior pole of thyroid. If not localised the following sites should be searched for ectopic parathyroid.

- Thyrothymic ligament
- Tracheoesophageal groove and behind the oesophagus
- Intrathyroidal
- Carotid sheath, so opening the sheath may reveal the parathyroids
- Transcervical thymectomy may be necessary especially in MEN
- Median sternotomy may be used as the last resort.

In case of single gland adenoma, surgical removal gives a complete cure (Fig. 4). In case of multiglandular hyperplasia, the strategy is to do a subtotal parathyroidectomy where three glands are removed and a small portion of the fourth gland (40–60 g) is left behind.

Fig. 3 Sestamibi scan indicating enlarged left lower parathyroid

Fig. 4 Operative photo showing removal of enlarged left lower parathyroid which was proven histopathologically to be a parathyroid adenoma
with intact blood supply. The alternative approach would be to do total parathyroidectomy and autotransplantation of parathyroid tissue in sternocleidomastoid muscle or the non-dominant forearm (brachioradialis). In case of parathyroid carcinoma, enbloc resection of parathyroid with ipsilateral haemithyroidectomy and nodal dissection is recommended.

All the tissues removed should be confirmed by frozen section. Patient undergoing either subtotal or total parathyroidectomy with autotransplantation are at risk of developing permanent HPT. To avoid this complication it is recommended that parathyroid tissue routinely be saved and cryopreserved for patients with multi-glandular disease.

Unilateral neck exploration

Given the fact that 80–85% of patients will have only a solitary adenoma, a bilateral neck exploration subjects 15–20% of patients to unnecessarily extensive surgery, with the attendant risks of recurrent laryngeal nerve injury and postoperative hypocalcaemia. This has prompted some surgeons to perform a unilateral neck exploration [17]. This change in practice has been made possible because of an improvement in preoperative localisation studies and the development of intraoperative PTH monitoring. Unilateral exploration relies not only on the ability to localise an adenoma preoperatively but also on careful patient selection. Patients with mutiglandular disease, MEN related hyperplasia and renal disease are not suitable for this approach.

Minimally invasive parathyroid surgery

Minimally invasive radio-guided parathyroidectomy

Patients with primary HPT undergo localisation of their tumours with sestambi scan. The procedure uses an intraoperative gamma-probe to direct the dissection according to the level of radioactivity. This probe helps the operator to focus directly on to the tumour location. It can prove useful in persistent or recurrent HPT. Good results have been obtained from this technique [18].

Minimally invasive endoscopic parathyroidectomy

This technique was first described by Gagner [19, 20]. Preoperative localisation with a sestamibi scan is necessary. Multiple ports are used for endoscopic dissection, the camera and gas insufflation. The gland is then retrieved via the largest incision. A quick PTH assay is performed after resection. Bilateral parathyroid exploration is possible.

Minimally invasive video-assisted parathyroidectomy

This technique requires no trocars or gas insufflations [21]. This technique gains access to the neck through a small midline incision made at the suprasternal notch. Once inside the neck the entire procedure is performed by blunt dissection endoscopically using small reusable surgical instruments. Preoperative localisation with a sestamibi scan is essential and usually combined with intraoperative PTH measurement. This technique also permits a bilateral exploration.

Intraoperative PTH measurement

The introduction of intraoperative PTH assay has been an important advance in the development of unilateral neck exploration. Intraoperative PTH is measured using quick assay method and a 50% reduction in baseline value of PTH after 10 minutes of excision of adenoma predicts postoperative normocalcaemia [22]. It should however be noted that this technique is not fool proof and one must be aware that both false positive and false negative results have been reported.

Secondary and tertiary HPT

Secondary HPT is the increased production of PTH in response to prolonged hypocalcaemia and is associated with hyperplasia of all parathyroid tissue. It is usually seen in patients with chronic renal failure and vitamin D deficiency. Most of them can be managed by medical therapy. Surgery may be indicated when there is uncontrollable hypercalcaemia, hyperphosphataemia, high levels of PTH (>500 pg/ml), bone erosions and osteitis fibrosa. Surgical options include either subtotal parathyroidectomy or total parathyroidectomy with autotransplantation. In a small proportion of cases of secondary HPT, continuous stimulation of the parathyroids results in adenoma formation and autonomous PTH secretion independently of calcium level. This is known as tertiary HPT. It is most frequently seen in patients after kidney transplantation.

Recently, drugs that enhance the sensitivity of calcium-sensing receptor (calcimimetics) [23] are being developed and in the future may offer an alternative to surgery in HPT. Routine serum calcium estimation may help in recognising many asymptomatic as well as symptomatic cases of HPT [24].

Conclusion

- Primary HPT can be definitely diagnosed with elevated PTH in hypercalcaemic patients without hypocalciuria.
- Surgery should now be considered early in the natural history of the primary HPT, even in asymptomatic patients.
1. Unilateral neck exploration are acceptable with preoperative localisation and peroperative PTH monitoring in appropriate cases.

2. Bilateral neck exploration remains a safe approach with an excellent success rate and is still regarded as gold standard.

3. Whether unilateral exploration is superior to bilateral approach in success rate, complication rate or cost effectiveness remains to be proved by more prospective randomised studies.

References


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QUESTIONS

Before reading the tutorial try answering the following questions. Answers can be found at the end of the text.

1. Hyperthyroidism
   a. Can be identified by high levels T3/T4 and Thyroid Stimulating Hormone (TSH)
   b. Is most commonly caused by Graves disease
   c. Patients are prone to exaggerated hypotensive response during induction of anaesthesia
   d. Increases Minimum Alveolar Concentration (MAC) values
   e. Thyroid surgery is usually first line treatment

2. Regarding superficial cervical plexus block
   a. C1-5 anterior primary rami form the cervical plexus
   b. Block can be achieved with infiltration along the posterior border of Sternocleidomastoid
   c. Phrenic nerve palsy is a common complication
   d. Could be used as a sole anaesthetic technique in a patient with a retrosternal goitre
   e. Can reduce postoperative morphine requirements.

3. Hypocalcaemia
   a. Should be diagnosed by total body calcium levels
   b. Can cause paraesthesiae
   c. Is indicated by Trousseau’s sign
   d. Can potentiate the negative inotropic effects of volatile anaesthetics
   e. Reliably prolongs non-depolarising neuromuscular blocking agents

INTRODUCTION

Thyroid surgery can range from simple removal of a thyroid nodule to highly complex surgery. The presence of longstanding or large goitres can pose difficult airway management decisions whilst endocrine imbalance can have profound systemic manifestations that need to be considered and controlled perioperatively.

This tutorial presents some of the more common thyroid pathologies that may be encountered, reviews the anaesthetic management of thyroid surgery plus looks at some of the common postoperative complications.
THYROID PATHOLOGY AND INDICATIONS FOR SURGERY

There are many indications for thyroid surgery, including: thyroid malignancy, goitres that produce obstructive symptoms and/or are retrosternal; hyperthyroidism resistant to medical management; cosmetic and anxiety related reasons. Patients with hypothyroidism usually respond to thyroxine therapy and surgery is rarely indicated.

Hyperthyroidism

Hyperthyroidism results from excess circulating T3 and T4. The vast majority of cases are caused by intrinsic thyroid disease. Indications for surgery include:

1. Grave’s disease: An autoimmune condition associated with diffuse enlargement and increased vascularity of the gland caused by IgG antibodies mimicking Thyroid Stimulating Hormone (TSH). It is the only cause of hyperthyroidism associated with eye signs and pretibial myxoedema. It can be associated with other autoimmune conditions.
2. Thyroid secreting adenomas often presenting as a solitary nodule.
3. Toxic Multinodular Goitre. More common in women; a goitre develops one or two nodules with hypersecretory activity.
4. Other causes that may or may not be associated with goitre include: Exogenous iodine, Amiodarone, Post irradiation thyroiditis. In this group, medical management has proved unsatisfactory and radioiodine is not suitable.

Hypothyroidism

May be from intrinsic thyroid disease or failure of the hypothalamo-pituitary axis. Those associated with goitre include:

1. Hashimoto’s thyroiditis. This is the commonest cause of hypothyroidism and although initially may cause gland enlargement will later lead to thyroid atrophy due to autoantibody destruction of the follicles.
2. Iodine deficiency. A lack of iodine leads to thyroid hormone depletion, Thyroid Stimulating Hormone (TSH) stimulation and gland hypertrophy. Dietary iodine deficiency can be found in mountainous areas.

Malignancy

These will most commonly present as thyroid nodules and are usually minimally active hormonally (patient is euthyroid). The most common types are Papillary and Follicular carcinomas arising from the epithelium that confer a good prognosis if confined to the gland. Medullary carcinomas arising from calcitonin producing cells are associated with Multiple Endocrine Neoplasia II (MEN), which may be linked with phaeochromocytoma and primary hyperparathyroidism. Lymphomas cause diffuse swelling of the gland and carry a very poor prognosis.

ANAESTHETIC CONSIDERATIONS

It is fundamental to ensure that patients are clinically and chemically euthyroid prior to embarking on elective thyroid surgery. Although the majority of cases may be straightforward the possibility of both expected and unexpected challenging airway situations should be anticipated.

Preoperative Assessment

History

This should be focused on establishing if the patient is clinically euthyroid and assessing for airway compromise. The symptoms of hyper and hypothyroidism can occur insidiously and a collateral history from family may be useful.
It is important to establish the pathological nature, position and size of the goitre to appreciate the complexity and potential complications that may occur. A large goitre that has been present for some time may be associated with tracheomalacia postoperatively. Symptoms of dysphagia, positional breathlessness with a difficulty lying flat, change in voice or stridor may alert the anaesthetist to possible difficulties with airway compromise on induction. Evidence of other systemic disease, cardiorespiratory compromise and associated endocrine or automimmue disorders should also be sought. For example, medullary thyroid cancer associated with phaeochromocytoma.

**Examination**

The patient should be assessed for signs of hyperthyroidism or hypothyroidism (Table 1).

An examination of the goitre or nodule should be performed to assess size and extent of the lesion. A fixed hard nodule suggests malignancy with possible tethering to surrounding structures and limited movement. An inability to feel the bottom of the goitre may indicate retrosternal spread. The trachea should be examined to check for any deviation or compression. Retrosternal or large goitres can compress surrounding structures and may elicit signs of superior vena cava (SVC) obstruction, Horner’s Syndrome, pericardial or pleural effusions. A mandatory detailed airway examination would also include assessment of atlantoaxial flexion and extension, thyromental distance, Mallampatti, mandibular protrusion and incisor distance.

**Table 1. Clinical features Hypothyroidism / Hyperthyroidism**

<table>
<thead>
<tr>
<th></th>
<th><strong>HYPERTHYROIDISM</strong></th>
<th><strong>HYPOTHYROIDISM</strong></th>
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<tbody>
<tr>
<td><strong>General</strong></td>
<td>Weight loss, Malaise, Muscle weakness, Heat intolerance, Cachexia, Palmar erythma, Proximal muscle wasting, Pretibial myxoedema (Graves disease)</td>
<td>Malaise, Cold intolerance, Myalgia, Arthralgia, Dry, coarse skin. ‘Peaches &amp; Cream complexion’, Loss of eyebrows, Hypothermia, Carpal tunnel syndrome, Myotonia</td>
</tr>
<tr>
<td><strong>Central nervous system</strong></td>
<td>Irritability, Anxiety, Hyperkinesis, Tremor</td>
<td>Poor memory, Depression, Psychosis, Mental slowness, Dementia, Poverty of movement, Ataxia, Slow relaxing reflexes Deafness</td>
</tr>
<tr>
<td><strong>Cardiovascular</strong></td>
<td>Palpitations, Angina, Breathlessness, Hypertension, Cardiac failure, Tachycardia, Tachyarrhythmis, Atrial fibrillation, Vasodilatation</td>
<td>Hypertension, Bradycardia, Heart failure, Oedema Pericardial &amp; pleural effusions, Anaemia, Cool peripheries</td>
</tr>
<tr>
<td><strong>Gastrointestinal</strong></td>
<td>Increased appetite, Vomiting, Diarrhoea</td>
<td>Constipation, Obesity</td>
</tr>
<tr>
<td><strong>Genitourinary</strong></td>
<td>Oligomenorrhoea, Loss of libido</td>
<td>Menorrhagia, Loss of libido</td>
</tr>
<tr>
<td><strong>Eye (Graves disease only)</strong></td>
<td>Blurred / double vision, Exophthalmos, Lid lag, Conjunctival oedema</td>
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</tbody>
</table>
Investigations

1. Routine blood tests include Full Blood Count (FBC), electrolytes, thyroid function and corrected calcium levels. It is imperative to ensure the patient is euthyroid prior to surgery to avoid complications of a thyroid storm or myxoedema coma in the perioperative period. FBC is essential due to the potential for blood loss during the procedure plus to detect any serious adverse haematological effects of concurrent antithyroid medications. (Table 2)

2. A CXR may be useful to assess the size of goitre and detect any tracheal compression or deviation. Lateral thoracic inlet views may also help to assess retrosternal extension and the tracheal anteroposterior diameter.

3. If there are any concerns regarding airway compromise, a CT scan is performed to determine the extent and location of tracheal narrowing or detect tracheal invasion.

4. Nasendoscopy is often performed preoperatively by ENT to document vocal cord function. This is an invaluable tool for the anaesthetist to assess the laryngeal inlet and any deviation from normal anatomy.

5. Respiratory flow volume loops may show fixed upper airway obstruction but performed routinely are rarely useful

Table 2. Anti-thyroid drugs

<table>
<thead>
<tr>
<th>DRUG</th>
<th>DOSE</th>
<th>MECHANISM OF ACTION</th>
<th>SIDE EFFECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbimazole</td>
<td>Initial: 15-40mg daily</td>
<td>Prodrug rapidly converted to methimazole.</td>
<td>Rashes, arthralgia,</td>
</tr>
<tr>
<td></td>
<td>Maintenance: 5-15mg daily</td>
<td>Prevents synthesis of T3 and T4 by blocking oxidation of iodide to iodine and inhibiting thyroid peroxidase</td>
<td>pruritis, myopathy,</td>
</tr>
<tr>
<td></td>
<td>Takes 6-8 weeks to work</td>
<td></td>
<td>Bone marrow suppression</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Agranulocytosis (0.1%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Crosses placenta: foetal hypothyroidism</td>
</tr>
<tr>
<td>Propylthiouracil</td>
<td>Initial: 200-400mg daily</td>
<td>Blocks iodination of tyrosine residues present in thyroglobulin.</td>
<td>Thrombocytopenia,</td>
</tr>
<tr>
<td></td>
<td>Maintenance: 50-150mg daily</td>
<td>Inhibits conversion of T4 – T3</td>
<td>Aplastic anaemia,</td>
</tr>
<tr>
<td></td>
<td>Takes 6-8 weeks</td>
<td></td>
<td>Agranulocytosis</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hepatitis, nephritis,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Crosses placenta: foetal hypothyroidism</td>
</tr>
<tr>
<td>Iodide/Iodine</td>
<td>Lugol’s solution: 5g Iodine solution in 10g</td>
<td>Large doses of Iodide inhibit hormone production.</td>
<td>Antithyroid effects diminish with time.</td>
</tr>
<tr>
<td></td>
<td>Potassium iodide: 0.1-0.3ml TDS</td>
<td>Reduced the effect of TSH.</td>
<td>Hypersensitivity reactions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Marked reduction in thyroid vascularity over 10-14days</td>
<td>Crosses placenta: foetal hypothyroidism</td>
</tr>
<tr>
<td>Propanolol</td>
<td>Oral: 40-80mg TDS (May need higher dose as metabolism increased) IV: 0.5mg titrated to effect</td>
<td>Controls sympathetic effects of thyrotoxic crisis. Blocks peripheral conversion of T4 to T3</td>
<td>Negative inotropy &amp; chronotropy.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Bronchospasm</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Poor peripheral circulation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CNS effects</td>
</tr>
</tbody>
</table>

Optimisation

Elective work should be postponed until the patient is euthyroid. On the day of surgery, usual antithyroid medications should be administered except for Carbimazole as it increases the vascularity of the gland. Benzodiazepines may be administered for anxiolysis but should be avoided if there is any
airway concern. Anticholinergics may be helpful to dry secretions if an inhalational or fibreoptic technique is planned.

In emergency surgery, it may not be possible to render those patients with uncontrolled thyroid disease euthyroid. In these circumstances, hyperthyroid patients should have immediate control of symptoms with beta blockade (e.g. propanolol, esmolol), intravenous hydration and active cooling if necessary. Severely hypothyroid patients are at risk of perioperative myxoedema coma and should be treated with intravenous T3 and T4.

Intraoperative Management

Historically thyroid surgery was performed under local anaesthesia. General anaesthesia is now the preferred technique but regional anaesthesia can still have a place either as a sole technique with or without sedation or alongside general anaesthesia to enhance analgesia.

Regional Anaesthesia

Regional anaesthesia for thyroid surgery is seldom used in the UK but has been successfully employed as the sole anaesthetic technique particularly in areas with limited resources. To achieve the most successful results a multidisciplinary team approach needs to be employed with appropriate patient selection, excellent patient education and modification of surgical technique.

A commonly used technique is bilateral C2-C4 superficial cervical plexus block performed under full monitoring with or without sedation. Conscious sedation can be achieved via increments of Midazolam or a Target Controlled Infusion (TCI) of Propofol. Bilateral deep cervical plexus blocks have a higher incidence of complications including vertebral artery and subdural injection, and notably bilateral phrenic nerve palsy, which may not be tolerated in some patients.

The nerves supplying the anterolateral part of the neck emerge from the posterior border of sternocleidomastoid (SCM) as the anterior rami of C2-C4, which divide into greater auricular, transverse cervical, lesser occipital and supraclaviclar nerves (Figure 1).

Figure 1: Superficial Cervical Plexus Block

To perform the superficial cervical plexus block, the patient should be positioned with their head extended to the opposite side, the midpoint of the posterior border of SCM visualised. 15-20mls of
local anaesthetic (e.g. lidocaine and/or bupivacaine with adrenaline) is injected in a superficial wheal deep to the first fascial layer in caudad and cephalad directions along the posterior border of SCM (Figure 1). For thyroidectomy, bilateral blocks should be performed. A midline field block can be achieved by a subcutaneous injection from the thyroid cartilage to the suprasternal notch. This is a useful addition to prevent the pain from surgical retractors on the medial aspect of the neck.

Regional anaesthesia avoids the risks of a general anaesthetic, allows intraoperative voice monitoring and provides excellent postoperative analgesia. The technique may be suited to medically compromised patients (including complicating thyrotoxicosis), or those with obstructive symptoms secondary to large goitres to avoid the risks of a general anaesthetic. However, these techniques do have a number of complications including local anaesthetic toxicity, haematoma, pneumothorax, and require excellent patient cooperation.

**General Anaesthesia**

A variety of techniques can be employed for general anaesthesia. In most cases, the patient can be given an intravenous induction and intubated with a reinforced tube. It is advisable to demonstrate manual ventilation prior to giving a non-depolarising muscle relaxant. Care should be taken to avoid overinflating the tube cuff (or use a cuff manometer) to minimise anaesthesia related cord/tracheal damage. In our institution, we spray the vocal cords with lidocaine prior to intubation, which may help reduce coughing on emergence.

If there are any concerns regarding airway patency or distorted anatomy alternative options should be considered. Further information on managing predicted and unpredicted difficult airways can be found on the Difficult Airway Society website.

1. Inhalational induction. The technique includes good preoxygenation and gradual induction with Sevoflurane. Airway adjuncts and difficult airway equipment should be immediately available if the airway is lost during induction.

2. If there is concern regarding distorted anatomy or that the airway may be lost altogether on induction, an awake fibreoptic intubation may be used. This technique should be avoided in those patients with marked symptoms of airway obstruction as complete obstruction may be provoked.

3. If either of these options are not suitable, a tracheostomy under local anaesthetic by the surgeons may be appropriate.

4. Ventilation through a rigid bronchoscope can be used if attempts at passing an endotracheal tube fail or if there is subglottic tracheal compression.

5. The Laryngeal Mask Airway (LMA) can be used for thyroid surgery but should be avoided in those with airway compromise or distorted anatomy. The use of an LMA has the advantage of allowing the assessment of the vocal cords intraoperatively via a fibreoptic scope with stimulation of the recurrent laryngeal nerve. It does not provide a definitive airway, and relies on close cooperation between the surgeon and anaesthetist to avoid displacement during surgery.

Intravenous or inhalation agents can be used for maintenance of anaesthesia. Good muscle relaxation is paramount and neuromuscular function should be monitored. Remifentanil infusion is commonly used as it reduces the need for muscle relaxation allowing for intraoperative electrophysiological testing of the recurrent laryngeal nerve in complicated cases. It can also be titrated against the blood pressure to assist in producing a bloodless surgical field during dissection, yet allow return to normal (supranormal) pressures prior to closure to check haemostasis. This may also require the use of a vasopressor such as phenylephrine boluses.

**Positioning**

For optimal surgical access the head is fully extended and rested on a padded ring with a sandbag between the scapulae. The eyes should be adequately padded and particular attention paid to those with exophthalmos. Access to the airway will be limited during the procedure so the endotracheal tube should be taped securely. Neck ties should be avoided. A head up tilt is preferable to allow venous
drainage although care must be taken to ensure arterial pressure is not compromised. As the arms are extended by the patient’s side, long extension leads on the drips are useful.

Retrosternal goitres can usually be removed via the cervical route. However, a few may require a sternotomy.

*Analgesia*

The surgeon will usually infiltrate local anaesthetic and adrenaline subcutaneously prior to incision that confers some analgesic effect into the postoperative period. Regular paracetamol, non-steroidal anti-inflammatories (NSAIDs) plus weak opioids are usually adequate to ensure the patient is comfortable but morphine maybe required. Bilateral superficial cervical plexus blocks can significantly reduce pain and morphine requirements in the postoperative period. Administration of antiemetics is important as these patients are at high risk of postoperative nausea and vomiting. We use a combination of ondansetron and/or cyclizine with dexamethasone, which may also help reduce postoperative airway oedema.

*Emergence*

At the end of the procedure the surgeon may request a Valsalva manoeuvre to check for haemostasis. If there have been any concerns regarding the integrity of the recurrent laryngeal nerve, then the vocal cords are visualised with either a laryngoscope, or a fibreoptic scope via an LMA (if in place or sited post deep extubation).

Neuromuscular blockade should be fully reversed, the patient sat up and endotracheal tube cuff deflated to ensure a leak prior to extubation. In our institution, we extubate our patients awake. It is important to minimise airway manipulation and head and neck movement during emergence, to prevent coughing and straining. If the vocal cords have been sprayed with lidocaine at intubation, this may also help to achieve a smooth emergence. Alternative techniques include extubation at a deep level of anaesthesia or intravenous lidocaine (1.5mg/kg). Steroids (e.g. dexamethasone 8mg) may help to reduce airway oedema if the procedure has been long or difficult.

*Postoperative Considerations*

*Haemorrhage*

Postoperative bleeding can cause compression and rapid airway obstruction. Signs of swelling or haematoma formation that is compromising the patient’s airway should be immediately decompressed by removal of surgical clips. Clip removers should be kept by the patient’s bedside. If there is time to return to theatre, reintubation should be performed early.

*Laryngeal oedema*

This is an uncommon cause of postoperative respiratory obstruction. It can occur as a result of traumatic tracheal intubation or in those who develop a haematoma that can cause obstruction to venous drainage. It can usually be managed with steroids and humidified oxygen

*Recurrent Laryngeal Nerve (RLN) Palsy*

Trauma to the recurrent laryngeal nerve can be caused by ischaemia, traction, entrapment or transection of the nerve during surgery and may be unilateral or bilateral. Unilateral vocal cord palsy will present with respiratory difficulty, hoarse voice or difficulty in phonation whilst bilateral palsy will result in complete adduction of the cords and stridor. Bilateral RLN palsy requires immediate reintubation and the patient may subsequently need a tracheostomy.

*Hypocalcaemia*

Unintended trauma to the parathyroid glands may result in temporary hypocalcaemia. Permanent hypocalcaemia may include confusion, twitching and tetany. This can be elicited in Trousseau’s (carpopedal spasm precipitated by cuff inflation) or Chvostek’s sign (facial twitch on tapping parotid gland) Calcium replacement should be instituted immediately as hypocalcaemia can precipitate laryngospasm, cardiac irritability, QT prolongation and subsequent arrhythmias.
Tracheomalacia
The possibility of tracheomalacia should be considered in those patients who have had sustained tracheal compression by large goitres or tumours. A cuff leak test just prior to extubation is reassuring but equipment should be available for immediate reintubation if it occurs.

Thyroid Storm
Characterised by hyperpyrexia, tachycardia, altered consciousness and hypotension this is a medical emergency. Although less commonly seen now as patients are rendered euthyroid prior to surgery it can still occur in patients with hyperthyroidism when they sustain a stress response such as surgery or infection. Management is supportive with active cooling, hydration, beta blockers and antithyroid drugs. Dantrolene 1mg/kg has also been successfully used in the treatment of thyroid storm.

SUMMARY
- Patients should be clinically and chemically euthyroid prior to thyroid surgery
- Perioperative airway complications are common and the expected or unexpected difficult airway should be anticipated.
- Postoperative complications of haematoma formation, recurrent laryngeal nerve palsy, hypocalcaemia and tracheomalacia can all cause airway compromise and must be acted upon quickly.
- Thyroid storm although less common than it used to be, is a medical emergency

ANSWERS TO QUESTIONS

1. FTTFF
Thyroid function tests classically reveal high levels of T3 and T4 but low levels of TSH suppressed by the negative feedback on the pituitary. The commonest cause is Grave’s disease. These patients can be chronically hypovolaemic and vasodilated and therefore do show exaggerated response to induction. Hyperthyroidism does not increase anaesthetic requirements. Thyroid surgery is considered after medical or radiiodine treatment.

2. FTFFT
Cervical plexus is formed from C1-C4. Phrenic nerve palsy is a common complication of deep cervical plexus block. A sole regional technique would not be appropriate in a patient with retrosternal goitre

3. FTTTF
Hypocalcaemia should only be diagnosed on the basis of plasma ionised calcium concentration, i.e. corrected for plasma albumin concentration. Paraesthesiae and Trousseau’s sign can occur. Decreased cardiac contractility will occur and potentiaton of negative inotropes should be expected. The response of NMBA is inconsistent.
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