Clinical aspects of endocrinology: parathyroid and adrenal gland disorders

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Abstract

The parathyroid glands are responsible for calcium homeostasis, which is necessary for appropriate functioning of the musculoskeletal and nervous system. Parathyroid adenoma remains the most common indication for surgery.

The adrenal cortex is mainly responsible for secretion of mineralocorticoids, glucocorticoids and androgens whereas the medulla consists of pre-ganglionic sympathetic ganglion, which secretes epinephrine, nor-epinephrine and dopamine. Adrenocortical disease results in disturbance of water balance, electrolytes, cardiovascular instability and metabolic disturbances.

Keywords Anaesthesia; calcium; Cushing's syndrome; glucocorticoids; mineralocorticoids; parathyroid adenoma

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Learning objectives

After reading this article you should be able to:

- state the signs and symptoms of hypercalcaemia and hypocalcaemia
- list the main hormones secreted by the adrenal gland
- describe the basic principles of anaesthetic management of patients presenting for parathyroid and adrenal surgery

Parathyroid gland

Four parathyroid glands lie in close association with the thyroid: two embedded in the superior poles and two in the inferior poles on the posterior aspect of the thyroid gland. In a thorough anatomic study, Akerstrom et al. described a 13% incidence of a supernumerary fifth parathyroid and, at most, a 3% incidence of only three glands.[1]

Physiology

The parathyroid glands are responsible for rapid control of calcium homeostasis.

The glands release parathyroid hormone (PTH) which stimulates osteoclasts to release calcium and phosphate into the extracellular fluid, and simultaneously increase phosphate excretion and calcium re-absorption in the kidney. PTH secretion increases in response to low serum concentrations of ionized calcium, and the release of the hormone is inhibited by an increase in serum-ionized calcium. Its coordinated actions on bone, kidney and intestine increase the flow of calcium into the extracellular fluid and increase the concentration of calcium in blood.[2]

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Pathophysiology

Parathyroid disease can be classified into hyperparathyroidism and hypoparathyroidism.

Hyperparathyroidism is characterized by overproduction of PTH and hypercalcaemia. It can be further classified as follows.

Primary hyperparathyroidism is caused by the excessive secretion of PTH from the glands. The most common cause is parathyroid adenoma, which accounts for 80–90% of cases. The UK incidence is estimated to be 25 per 100,000, and increases with age with the average age at diagnosis being 55 years.[3]

A family history must also be taken to identify familial hyperparathyroidism, multiple endocrine neoplasia (MEN) type I and MEN type II or familial hypercalcaemic hypocalciuria (FHH).[4]

Secondary hyperparathyroidism is a condition in which PTH is elevated to compensate for chronically low concentration of calcium with no intrinsic parathyroid abnormality. Vitamin D deficiency and renal failure are the two most common causes of secondary hyperparathyroidism.

Tertiary hyperparathyroidism is the condition in which parathyroid hyperplasia progresses to autonomous hypersecretion, so that excessive PTH secretion continues despite the presence of high concentration of calcium.

Ectopic hyperparathyroidism (pseudo-hyperparathyroidism) is due to secretion of PTH by tissues other than the parathyroid glands. Carcinoma of the lung, breast, pancreas, oesophagus or the kidney is the most common site.

The majority of patients with hyperparathyroidism are asymptomatic and the classical description of 'moans, groans and stones' is rarely seen. The main manifestations of hyperparathyroidism along with the anaesthetic implications are highlighted in Table 1.

Hypoparathyroidism is mainly encountered in post-surgical patients or as a complication of medical conditions. The main aetiology, signs and symptoms and anaesthetic considerations are highlighted in Table 2.

Medical and surgical management

Medical management of hyperparathyroidism aims to treat hypercalcaemia. Adequate hydration, loop diuretics after hydration (as they limit the resorption of calcium from the loop of Henle), and bisphosphonates are usually used. Alfacalcidol supplementation is usually used in patients with secondary hyperparathyroidism. Patients who are on dialysis for secondary hyperparathyroidism, cinacalcet is recommended by NICE in whom the PTH levels are very high and who cannot undergo surgery.[5]

Signs and symptoms of hypercalcaemia due to hyperparathyroidism

System	Manifestation	Considerations
Neuromuscular	Skeletal muscle weakness with hypotonia especially affecting proximal lower limb muscles	Monitoring of neuromuscular function Resistance to muscle relaxants Reduced dose if muscle weakness
Nervous system	Somnolence, psychosis, decrease pain sensation, cognitive changes	Appropriate preoperative assessment
Renal	Polyuria, polydipsia, nephrolithiasis, renal failure	Fluid balance, good hydration, monitor renal function, arterial blood gas for acidosis, CVP monitoring rarely
Cardiovascular	Hypertension, valvular calcifications, arrhythmias, prolonged PR interval, short QT interval	ECG, echocardiography in symptomatic patients, anti-hypertensive therapy, arterial line if necessary. Maintain normothermia
Haematological	Anaemia	Monitor full blood count
Gastrointestinal	Abdominal pain, vomiting, peptic ulcer, pancreatitis	Monitor LFTs, amylase, consider proton pump inhibitors in premedication, rapid sequence induction if symptomatic
Skeletal	Skeletal demineralization, osteoporosis, osteitis fibrosis cystica, periarthritis, periarticular calcification, bone pain, pathological fractures	Monitor calcium, phosphorus and magnesium levels. Appropriate positioning during the perioperative period

CVP, central venous pressure; ECG, electrocardiogram; LFTs, liver function tests.

Table 1

Parathyroid surgery is usually performed when there is symptomatic primary hyperparathyroidism. In asymptomatic patients,[6] surgery is indicated if:

- the patient's age is less than 50 years
- glomerular filtration rate (GFR) is under 60 ml/minute
- serum calcium is on the upper normal level limits
- there is evidence of poor bone mineral density.

Surgery helps to reverse the cardiovascular and neurological changes, improves the functional quality of life and decreases the risk of death.[7] Surgery in patients with renal hyperparathyroidism (RHPT) is only indicated in cases of refractory medical management and in the presence of complications of RHPT.

There are several options for surgical approach: full cervical exploration, limited neck dissection or minimally invasive parathyroid surgery, which is most commonly achieved through a 2-cm skin incision placed over the appropriately localized solitary parathyroid adenoma. The adenoma can be easily localized by technetium-99 sestamibi scanning and high-resolution ultrasonography. CT and MRI can also be helpful in localizing abnormal parathyroid glands.

Anaesthetic considerations

The main anaesthetic considerations during the perioperative period are highlighted in Tables 1 and 2. Local anaesthesia, regional anaesthesia involving superficial cervical plexus blocks (with or without sedation) or more commonly general anaesthesia (GA) have been used for parathyroid surgery. Local and regional anaesthesia are increasingly being employed for minimally invasive parathyroid surgery and also used for patients with marked cardiovascular disease.

Both, laryngeal mask airway or reinforced endotracheal tubes have been used for airway management during a GA. The patient is positioned with the neck extended to provide better access to the operating area. Head-up position decreases venous congestion,

Aetiology with signs and symptoms of hypocalcaemia due to hypoparathyroidism

Aetiology	Signs and symptoms	Considerations
• Accidental removal of parathyroid glands during thyroidectomy • Parathyroidectomy • DiGeorge syndrome • Chronic renal failure • Hypomagnesaemia • Malabsorption • Anti-convulsive therapy • Pancreatitis	Mainly due to hypocalcaemia: • Peri-oral paraesthesia, restlessness, neuromuscular irritability, tetany. Cognitive dysfunction and seizures • Chvostek sign — tapping over the facial nerve produces facial muscle twitching • Trousseau sign — carpopedal spasm produced by limb ischaemia due to a limb tourniquet or a blood pressure cuff inflation • Prolonged QT interval on ECG • Cataracts and abnormal calcification • Inspiratory stridor	Monitor ionized calcium levels Administer calcium gluconate or calcium chloride along with vitamin D if necessary Monitor renal function Avoid hyperventilation Avoid hypothermia

Table 2