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 systems. Parathyroid adenoma remains the most common indication for surgery. Anaesthetic considerations for parathyroid surgery include good hydration, appropriate positioning, monitoring renal function along with serum electrolytes. The adrenal cortex is mainly responsible for secretion of mineralocorticoids, glucocorticoids, and androgens whereas the medulla consists of preganglionic sympathetic ganglion, which secretes epinephrine, norepinephrine and dopamine. Adrenocortical disease results in disturbance of water balance, electrolytes, cardiovascular instability and metabolic disturbances. Correction of water, electrolyte imbalance, blood pressure control with invasive monitoring, appropriate positioning, analgesia with appropriate hormone replacement therapy form the key principles of the anaesthetic management.

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

Parathyroid gland
Surgical anatomy
Successful surgical management of parathyroid disease depends not only on correct biochemical diagnosis, but also on a good understanding of the anatomic locations of the parathyroid gland. About 84% of the patients have two superior and two inferior parathyroid glands. The superior parathyroid glands are located on the posterior-lateral aspect of superior thyroid lobe, usually outside the thyroid capsule. Inferior parathyroid glands lie near the lower pole of thyroid gland in the majority of patients.

About 13% of patients have supernumerary glands (found anywhere from thyroid to thymus) and about 3% of patients have only three glands.

Parathyroid disease
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**: PTH secretion is inappropriately high in relation to serum calcium concentration. Up to 80–85% of cases of primary hyperparathyroidism are caused by a single adenoma, while 2–5% of cases are due to double adenomas. The UK incidence is estimated to be 25 per 100,000, and increases with age with the average age at diagnosis being 55 years. Multiple gland hyperplasia accounts for approximately 6% of cases of primary hyperparathyroidism. Parathyroid carcinomas account for 1–2% of cases of hyperparathyroidism. Some conditions are associated with primary hyperparathyroidism. For example, 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). Familial isolated hyperparathyroidism (FIHP) is a term given to familial primary hyperparathyroidism not associated with any other endocrine disorder.

- **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 or pseudohyperparathyroidism** is due to secretion of PTH by tissues other than the parathyroid gland. Carcinoma of the lung, breast, pancreas, oesophagus, or kidney are the most common.

**Clinical presentation**

The most common clinical presentation of hyperparathyroidism is asymptomatic hyperparathyroidism detected on biochemical screening.

The classic presentation of moans, groans, and stones is rarely seen in the developed world. The main manifestations of hyperparathyroidism and along with anaesthetic implications are highlighted in Table 1.

**Medical management**

For patients not undergoing surgery, following preventive measures are recommended:

- Avoiding factors that exacerbate hypercalcaemia like use of thiazide diuretics and lithium therapy, dehydration, prolonged bed rest, and a high calcium diet.

- Encouraging physical activity, which reduces bone resorption.

- Encouraging adequate hydration to reduce risk of renal stones.

- Decrease dietary intake.

- Maintain moderate vitamin D intake as decreased vitamin D stimulates PTH secretion.

- Cinacalcet (a calcimimetic) is used for patients with symptomatic and severe hypercalcemia who are unable to have surgery and are on dialysis (NICE recommendation). It normalizes serum calcium levels by activating the CaSR in the parathyroid gland and inhibiting PTH secretion.

- Bisphosphonates are recommended for patients with primary hyperparathyroidism and bone disease (osteoporosis or low bone mineral density) who wish to avoid surgery. It is a potent inhibitor of bone resorption.

Patients not undergoing surgery should have their serum calcium, renal function (creatinine, estimated glomerular filtration rate [eGFR]) and bone density monitored every 1–2 years.

**Surgical management**

The indications for surgery are as follows.

- Symptomatic primary hyperparathyroidism: parathyroid surgery is the only definitive therapy for symptomatic patients and it cures the disease, decreases the risk of kidney stones, improves bone mineral density and decreases fracture risk. Surgery also improves the functional quality of life and decreases the risk of death.

- **Asymptomatic patients:**

  For asymptomatic patients surgery is indicated if:
  - serum calcium concentration is 0.25 mmol/litre or more above the upper limit of normal
  - eGFR is <60 ml/minute
  - there is nephrolithiasis or nephrocalcinosis
  - 24-hour urinary calcium is >10 mmol/day
  - there is poor bone mineral density

### Signs and symptoms of hypercalcaemia due to hyperparathyroidism

<table>
<thead>
<tr>
<th>System</th>
<th>Manifestation</th>
<th>Consideration</th>
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<tbody>
<tr>
<td>Neuromuscular</td>
<td>Skeletal muscle weakness with hypotonia affecting proximal lower limb muscles</td>
<td>Reduced dose if muscle weakness.</td>
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<tr>
<td></td>
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<td>Monitoring of neuromuscular function.</td>
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<td>Resistance to muscle relaxants.</td>
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<tr>
<td>Nervous system</td>
<td>Somnolence, psychosis, decrease pain sensation, cognitive changes, decreased concentration, confusion</td>
<td>Appropriate preoperative assessment and documentation.</td>
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<tr>
<td>Cardiovascular</td>
<td>Hypertension, valvar calcification, arrhythmias, bradycardia, prolonged PR and short QT interval.</td>
<td>ECG, echocardiography in symptomatic patients, anti hypertensive therapy, arterial line if necessary.</td>
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<tr>
<td>Haematological</td>
<td>Anaemia</td>
<td>Monitor full blood count.</td>
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<tr>
<td>Gastrointestinal</td>
<td>Abdominal pain, vomiting, peptic ulcer, pancreatitis.</td>
<td>Monitor LFT, amylase, consider PPIs in premedication, RSI if symptomatic.</td>
</tr>
<tr>
<td>Skeletal</td>
<td>Osteoporosis, osteitis fibrosis cystica, periarticular calcification, bone pain, pathological fractures.</td>
<td>Monitor calcium, phosphorus, and magnesium levels.</td>
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| ABG, arterial blood gases; CVP, central venous pressure; ECG, electrocardiography; LFT, liver function test; PPI, proton pump inhibitor; RSI, rapid sequence induction. |

Table 1