The Egyptian Journal of Hospital Medicine (October 2022) Vol. 89 (2), Page 7207- 7210

Relevant Correlation between Hypocalcemia and Thyroidectomy Operation: Review Article

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ABSTRACT

Background: One of the most popular surgical procedures performed worldwide is thyroid surgery, which is regarded as the best solution for benign conditions like multinodular goitre with compressive symptoms and thyroid cancer. The most common side effects of thyroid surgery include postoperative haemorrhage, parathyroid insufficiency, and recurrent laryngeal nerve damage. The removal of the glands during surgery may cause hypoparathyroidism. Following thyroidectomy, hypocalcemia is a common consequence that has a high risk of mortality and has been linked to longer hospital stays, postoperative problems, and higher readmission rates.

Objective: Assessment of incidence of hypocalcemia as postoperative complication of thyroidectomy operation.

Methods: We searched PubMed, Google Scholar, and Science Direct for information on hypocalcemia with thyroidectomy. However, only the most current or comprehensive study from February 2004 to July 2022 was considered. The authors also assessed references from pertinent literature. Documents in languages other than English have been disregarded since there aren't enough resources for translation. Unpublished manuscripts, oral presentations, conference abstracts, and dissertations were examples of papers that weren't considered to be serious scientific research.

Conclusion: A highly effective and simple predictor of hypocalcemia in individuals undergoing total thyroidectomy is the comparison of the post-operative drop in calcium levels to the immediate pre-operative readings.

Keywords: Hypocalcemia, Complication of thyroidectomy operation.

INTRODUCTION

For safe thyroid or parathyroid procedures, it is crucial to have a detailed grasp of the vascular system, laryngeal nerves, and the anatomical interactions and variations of the thyroid and parathyroid glands. Early thyroidectomies had a fatality rate of up to 40% and were riddled with deadly consequences throughout the first half of the 19th century. [(1)]**.** Thyroidectomy was indicated to be done only in extreme cases during this time. In an effort to reduce the morbidity and mortality of this procedure, several surgeons, notably Billroth, Kocher, and Halsted undertook detailed studies of the vascular architecture of the thyroid. In the second half of the 19th century, as understanding of the architecture of the thyroid, parathyroid glands, laryngeal nerves, and vascular anatomy expanded, this technique became safer. Additionally, as surgical tools advanced, so did patient safety [(2)]. The main cells and the oxyphil cells are two different kinds of cells found in the parathyroid glands. When the cells are examined, they have a developed endoplasmic reticulum and a conspicuous Golgi apparatus, which aid in the hormone's manufacture and secretion. Despite being smaller than oxyphil cells, chief cells are more prevalent. It is unclear what Oxyphil cells are used for? They appear to multiply with age and are bigger than the primary cells [(3)].

Function:

Chief cells and oxyphil cells are the two different cell types that make up the parathyroid glands. The principal (chief) cells control the release of parathyroid hormone (PTH). To aid in the production and release of the hormone, the cells have a well-developed endoplasmic reticulum and a conspicuous Golgi apparatus. The main cells are more prevalent, while being smaller than oxyphil cells. Uncertainty surrounds the function of Oxyphil cells. They are bigger than the primary cells and appear to multiply with age [(4)]**.**

Kidney:

PTH promotes phosphate excretion and calcium reabsorption. The distal tubule, ascending loop of Henle, and collecting tubules all work to enhance reabsorption. The proximal tubule is where phosphate reabsorption is prevented. By activating 1-hydroxylase in the proximal tubules, PTH encourages the conversion of 25-hydroxyvitamin D into its active form (1, 25-dihydroxy vitamin D-3) [(5)].

Intestine:

Due to an increase in calcium-binding protein production in intestinal epithelial cells, activated vitamin D facilitates calcium absorption [(3)].

Bone:

Both osteoblastic and osteoclastic cells are impacted by PTH's rapid phase. Calcium can be pumped out of the osteocytes membrane when PTH interacts to the receptors on cells. This has an instant impact and enables the rise in calcium to take place within a short period of time. Slow Phase: A rise in blood serum calcium levels is precipitated over the course of many days during the slow phase. Due to the absence of PTH receptors in mature osteoclasts, this process takes place through the osteoblast. Through the use of cytokines, the osteoblast activates the mature osteocytes. Additionally, osteoclast proliferation takes place [(4)]**.**

Received: 14/07/2022
Accepted: 17/09/2022

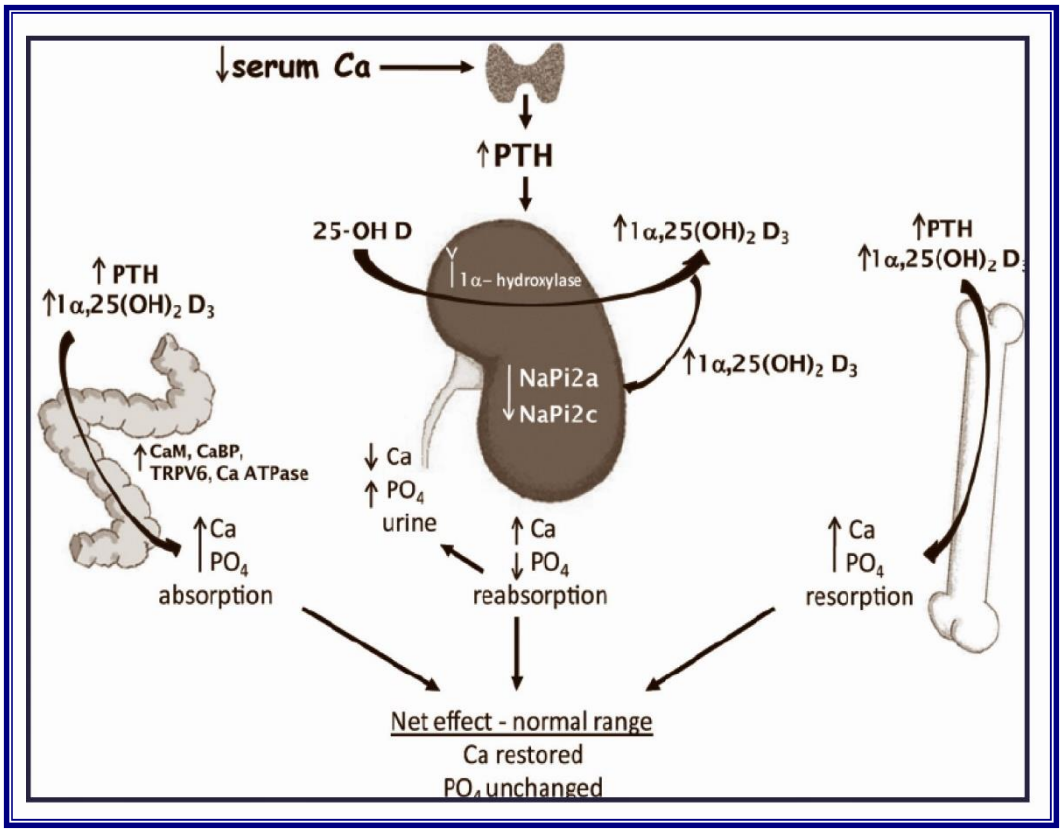

Figure (1): The parathyroid hormone's physiology (PTH) [6].

A significant advancement in surgical technique was linked to that shift in thinking during a 25-year period, and as a result, total thyroidectomy is now available as a minimally invasive, safe, and effective operation with better results [7].

Many a meticulously dissected parathyroid gland simply infarcts later due to thrombosis of the flimsy vascular supply or due to oedema and enlargement of the gland within its dissected capsule [8].

Complications of thyroidectomy:

Very few people experience persistent issues after a thyroidectomy. Due to the thyroid gland' close anatomic proximity to the recurrent laryngeal nerves (RLN) and the parathyroid glands. Temporary dysphonia (which occurs in 5–11% of cases and may become permanent in 1-3.5%) and temporary hypoparathyroidism (which occurs in 20–30% of cases and may become permanent in 1-4%) are two common complications following thyroid surgery. These figures, which are drawn from the most comprehensive recorded series, show the frequency of issues seen in centers of competence [9].

Acute dyspnea and postoperative compressive hematoma are rare but serious complications that might cause death or serious long-term effects. There are several risk factors, such as patient-related ones (prior cervical surgery), procedure-related ones (lymph-node dissection), thyroid pathology (thyroiditis or malignancy), surgical volume, and surgeon experience. At the initial session, the patient should get information outlining potential severe and/or everyday dangers and how to handle them [10].

A total blood calcium level of less than 2 mM/L (8.0 mg/dL) or an ionised calcium level of less than 1.1 mM/L (0.275 mg/dL) is considered to have hypocalcemia. Depending on the language the writers employ, the incidence of post-thyroidectomy hypocalcemia ranges from 2 percent to 83 percent. Only symptomatic hypocalcemia is covered by some writers, whereas asymptomatic hypocalcemia linked to temporary hypoparathyroidism is included by others [11].

Pathology:

Hypocalcemia is frequently brought on by hypoparathyroidism. The parathyroid hormone (PTH) strictly controls calcium levels. PTH levels increase in reaction to low calcium levels, and vice versa, PTH production decreases in response to high calcium levels. The body, however, loses its regulating role when PTH hormone is missing, low, or inadequate, and hypocalcemia results. Surgery to remove the parathyroid glands is a common cause of hypoparathyroidism. Autoimmune issues can potentially result in hypoparathyroidism [10].

Clinical picture:

As a result of reduced calcium-sodium channel interaction, which has a beneficial bathmotropic effect, hypocalcemia's neuromuscular symptoms are brought

on (i.e., increased responsiveness). The depolarization threshold is lowered by calcium, which obstructs sodium channels and stops nerve and muscle fibres from depolarizing. The acronym "CATs go" can be used to recall the symptoms, which include tetany, numbness around the hands, feet, and mouth, convulsions, and arrhythmias [12].

- Petechiae (bigger bruised areas, typically in dependent sections of the body) that initially begin as on-off patches before confluently transforming into purpura).
- Paresthesia's of the mouth, lips, and acromion, as well as tingling or "pins and needles" sensations in the hands and feet's extremities. This is frequently the first sign of hypocalcemia.
- Latent tetany: Chvostek's sign and the Trousseau sign of latent tetany, which involves inducing a carpal spasm while keeping a blood pressure cuff pressure above systolic.
- Reflexes in the tendon are quick.
- Potentially fatal side effects include cardiac arrhythmias.
- Modifications to cardiac output [10].

Diagnosis:

Because albumin and calcium are related in significant amounts, any change in albumin levels will affect the calcium level being evaluated. Corrected calcium (mg/dL) is calculated as follows: measured total calcium (mg/dL) + 0.8 * (4.0 - serum albumin [g/dL]), where albumin is a blood protein that is measured. As albumin and the anion gap are both related to calcium, it would be more advantageous to regulate total calcium for both of these parameters [12].

Postoperative hypocalcemia and management:

Postoperative hypocalcemia is caused by decreased parathyroid hormone (PTH) secretion, which often causes hyperphosphatemia and hypocalcemia. Total blood calcium levels are also decreased by the typical postoperative reaction to surgical stress, which includes hemodilution and antidiuretic hormone release. Total serum calcium is approximately 50% in ionized form, 40% is albumin-bound, and 10% is complexed to phosphate or citrate [9].

The possibility of post-thyroidectomy hypoparathyroidism has been examined in several researches. An isolated calcium level is not as good a predictor of hypocalcaemia as the postoperative PTH level. The predictive value is increased by measuring the relative PTH decline [10].

Several variables raise the risk of postoperative hypocalcaemia, whether it is temporary or chronic:

- The thyroid circulation serves as the only route for the upper parathyroid glands' venous drainage.
- The parathyroid glands may be entirely intrathyroidal and difficult to recognise during surgery, especially for the inferior glands, in patients with big goitres, or they may occasionally reside beneath the thyroid capsule, resulting in a 6 to 21% risk of accidental parathyroidectomy. Although the danger of lifelong hypocalcemia is less than 2%, this can occasionally cause temporary hypocalcemia in 50% of cases
- Lower parathyroid glands are frequently removed in cases of extreme goitre, Grave's disease, or thyroid cancer necessitating extensive nodal dissection. Increased stress at the surgical site from repeated cervical examination and adhesions poses a risk of revascularizing the parathyroid glands.
- Both youth and female sex [9].

The parathyroid glands should be thoroughly located, visualized/saved, and their circulatory supply properly preserved by surgical dissection and sparing of the periglandular fat are all intraoperative strategies to decrease hypocalcemia. By adopting these steps, the long-term detrimental effects of low-grade chronic hypocalcemia on bone metabolism are less likely [13].

Beginning a week prior to surgery and continuing for two weeks afterwards, oral calcium supplementation with vitamin D (cholecalciferol) is given to patients during the peri-operative period. This lessens the frequency and severity of postoperative hypocalcemia, which enhances the patient's quality of life [11].

The last recommendation is to routinely check for vitamin D deficiency (25-OH- VitD3 below a threshold level of 20 ng/ml) prior to surgery. At the initial visit, vitamin D3 levels should be checked, and if necessary, supplements should be provided. It is most typical to provide 100,000 IU of oral cholecalciferol. After two months of recovery from surgery, a second Vitamin D3 level should be checked. Vitamin D deficiency is best discovered at the initial consultation [9].

Treatment involves regular calcium and vitamin D medication if the patient exhibits symptoms (paresthesia, neuromuscular excitability). Usually, the first dose of calcium carbonate is 500–1000 mg. Calcium citrate can be used if there is underlying achlorhydria since calcium carbonate needs an acidic environment for gastrointestinal absorption (i.e., with PPI drugs). First, 0.5 to 1 micrograms of vitamin D in the form of calcitriol are administered twice a day [9].

Based on weekly assessments of calcium and phosphate levels, dosages should be modified until biological equilibrium is reached. Magnesium deficiency, which might result in PTH resistance, must be recognised and treated (1.5 g of magnesium per day). Levothyroxine's bioavailability is decreased by calcium salts, hence the first dosage of calcium per day should be given several hours after the thyroid hormone replacement dose [10].

CONCLUSION

A highly effective and simple predictor of hypocalcemia in individuals undergoing total thyroidectomy is the comparison of the post-operative drop in calcium levels to the immediate pre-operative readings.

Financial support and sponsorship: Nil.
Conflict of interest: Nil.

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