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# Post-thyroidectomy hypocalcemia and related complications: A review

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***Abstract*---**The incidence of post-thyroidectomy hypocalcemia is high while the factors involved include age (> 50 years), type of operation, operative time, neck dissection, histology of the surgical specimen and vocal fold paralysis. Low ionic calcium concentrations are indicative of the presence of symptoms of hypocalcemia and the need for oral calcium. Progression to definitive hypoparathyroidism occurs only in patients with clinical manifestations of post-thyroidectomy hypocalcemia. In general, the problem with post-surgical hypoparathyroidism resides in the surgical procedure itself. The most common are related to neuronal hyperexcitability, which explains the paresthesias, cramps and numbness, which usually start in the perioral region and on the fingertips. Muscle spasms and muscle stiffness are also common. When severe, hypocalcemia can lead to life-threatening spastic tetany, laryngospasm, and seizures. The current manuscript aimed to present a review of the bibliography on thyroidectomy and negative impact of its complications on human health, mainly because of a higher risk for developing hypocalcemia. To achieve the study goal, this review covered most recent published articles from 2017 onward.

***Keywords*---**post-thyroidectomy hypocalcemia, related complications, patients.

## Introduction

Thyroidectomy is the main therapeutic method for neoplastic and hyperplastic thyroid diseases (Galesanu, Niculescu, Apostu, & Romeo, 2018; Manatakis, Bakavos, Soulou, Dimakis, & Tseleni-Balafouta, 2019), and it is also used in the treatment of selected cases of functional diseases (Jongekkasit, Jitpratoom, Sasanakietkul, & Anuwong, 2019). It is one of the most frequently performed operations in the world, with an incidence of acceptable complications and sequelae, which, however, can be extremely uncomfortable, disabling and, rarely,


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lethal (Boutzios, Tsourouflis, Garoufalia, Alexandraki, & Kouraklis, 2019; Reinhart et al., 2018). There are anatomical and metabolic complications that are peculiar to it and others that are common to all types of operation (Kaptanoglu, 2022; Panduranga Rao, 2022). The anatomical complications are related to damage to the recurrent laryngeal nerve and/or the external branch of the superior laryngeal nerve(Jin & Sugitani, 2021; Mahyoub et al., 2021).

Throughout the time that the metabolic complications are related to changes in calcium ion concentration and thyroid function (Z. Chen et al., 2021; Chincholikar & Ambiger, 2018; Metere, Biancucci, Natili, Intini, & Graves, 2021). Among the complications common to different surgical procedures, bleeding, surgical wound infection and seroma formation stand out (Khadra, Bakeer, Hauch, Hu, & Kandil, 2018; Voruganti, 2022). Serum calcium is found bound to proteins (50.0%), free or ionized (45.0%) and bound to organic complexes (5.0%)(Babu, 2021; Dhahri et al., 2021; D. H. Kim et al., 2021; Pelle, 2017) .

Calcium homeostasis is mediated mainly by parathyroid hormone (PTH), calcitonin and 1,25-dihydroxycholecalciferol (vitamin D) (Tageldin & Martin, 2020). The magnesium ion is directly related to calcium, and the abrupt drop in its concentration leads to a decrease in the production and release of PTH, in addition to exacerbating the clinical manifestations secondary to hypocalcemia. Phosphorus concentration is inversely proportional to calcium, being also mediated by PTH and vitamin D2 (Mahmoud F Sakr, 2022c; A. Shifrin, 2020).

Hypocalcemia is one of the most feared complications after thyroidectomy. Although its control is reasonably easy, it can generate late consequences, such as early cataracts and changes in bone metabolism, determining the onset or worsening of osteoporosis (more important in women, precisely those most submitted to thyroidectomy), in addition to, often prolong the period of hospitalization, increasing treatment costs (Pillai, Foster, & Ashraf, 2022; Mahmoud F Sakr, 2022c; A. Shifrin, 2020).

During thyroidectomy, damage to the parathyroid glands may occur, either by direct manipulation or by injury to their vascular pedicle, with a drop in serum PTH concentration and, consequently, , of calcium. The incidence of postoperative hypocalcemia varies considerably according to data from the world literature (Daba, Weldemichael, & Mulugeta, 2019; Y. Kim, Kim, Lee, & Ahn, 2018; Yamamoto et al., 2022). Most cases are secondary to temporary hypoparathyroidism, with recovery in three weeks to six months. However, 0.0% to 33.0% of patients will have definitive hypoparathyroidism (Daba et al., 2019; Y. Kim et al., 2018; *Short Textbook of Surgery*, 2010; Yamamoto et al., 2022).

In the postoperative period, if not investigated, hypocalcemia may go unnoticed, as it is often asymptomatic. Phosphorus and magnesium ions, which interfere with calcium metabolism, can also change after thyroidectomies and exacerbate the clinical manifestations of hypocalcemia (*Short Textbook of Surgery*, 2010). A more abrupt and intense drop in calcium concentration contributes to the onset of symptoms. It is not yet known at what calcium concentration the patient may have symptoms and even if this is of any clinical importance (Liu et al., 2020).

Since the first documented successful operation in the early 1880s, several studies have been trying to define, without reaching a consensus, which are the predictive factors for hypocalcemia (C. Patel & Shetty, 2020; Slough et al., 2021). Many factors may be involved in the development of post-thyroidectomy hypocalcemia, including extensive operations, neck dissection, women with preoperative hyperthyroidism, and/or a surgical procedure performed by an inexperienced surgeon (Pãduraru, Ion, Carsote, Andronic, & Bolocan, 2019; Radakrishnan et al., 2021; Spartalis et al., 2019).

However, not all patients with these factors will develop hypocalcemia, probably because, for that, other causes compete. The identification of these causes seems fundamental for their prevention. The evolution and consequences of asymptomatic hypocalcemia also need to be further investigated. The hypocalcemia with related complications induced by thyroidectomy, and influence of them on human health are presented in this review paper.

**History of thyroidectomy**

The anatomy of the thyroid gland was initially described by Leonardo da Vinci in 1500, and by Andréas Vesalius, in 1543, as quoted by Giddings (Giddings, 1998; Ignjatović, 2010). From that date, until mid-1872, thyroid surgery was reserved for selected cases of voluminous goiter with upper respiratory and digestive obstruction, as mortality rates were around 40.0% (Giddings, 1998; Ignjatović, 2010). Advances in surgical techniques, anesthesia and technology applied to medicine have determined a significant reduction in post-thyroidectomy complications (Al-Hussain et al., 2020; Ale, Isichei, & Misauno, 2020; Alghamdi, 2019).

According to Liorente et al., (2021) and Linos and Chung (2012), the improvement of antisepsis techniques, hemostasis, the refinement of the surgical technique and the discovery of the function of the parathyroid gland in the late 19th and early 20th centuries (Linos & Chung, 2012; Llorente, Laguado, Prats, Martínez, & Barrasa, 2021). These developments in thyroidectomy reduced post-thyroidectomy mortality to approximately 8.0% (Linos & Chung, 2012; Llorente et al., 2021). In the same way, the Emil Theodor Kocher received the Nobel Prize in recognition of his work on the physiology, pathology and surgery of the thyroid gland (Mudry & Orloff). Currently, the mortality rate is less than 1.0%, reaching 0.0% in many services (Gado, 2019; Linos & Chung, 2012).

**Parathyroid gland and consequences of its resection**

According to several researchers, the parathyroid glands were described in 1839 by Albers, but their physiological importance remained obscure for almost 60 years, until Kohn showed, in 1896, that they originate from the third and fourth arches. gill and that its morphology, function and embryology are different from those of the thyroid (Gado, 2019; Linos & Chung, 2012; Mokrysheva & Krupinova, 2019; A. S. L. Yu et al., 2015). Two years later, Welsh described the first anatomical details of the parathyroid glands in humans, with particular reference to their location and vascularization (Mokrysheva & Krupinova, 2019; M.F. Sakr, 2022). Not long after, in 1907, Halsted and Evans demonstrated that the superior and inferior parathyroid glands are generally irrigated by the inferior thyroid artery and, occasionally, the superior glands receive irrigation from both thyroid arteries (Mokrysheva & Krupinova, 2019; M.F. Sakr, 2022).

According to Sakr et al., (2022), the complete anatomy of the parathyroids was only described in 1938, by Gilmour, whose work, carried out on cadavers, showed the presence of four glands in 87.0% of the cases and a variation of two to six glands in 13.0% remaining (Mahmoud F Sakr, 2022a). He also reported that the inferior glands were close to or associated with the thymus in 32.0% of the cases and that there was a greater association of supernumerary parathyroid glands in cadavers with bicornuate thymus. Saint and Chopra (2018) reported that tetany as a complication of thyroidectomy was described by Kocher in 1883, being initially attributed to thyroid insufficiency (Saint & Chopra, 2018).

As metioned by several studies, Slough et al., (2021) and Sakr, (2022b) demonstrated that tetany appeared after parathyroid ablation, even when the thyroid was left intact (Mahmoud F Sakr, 2022e; Slough et al., 2021). Lebrun et al., (2020) commented that Parhon and Urechie demonstrated, in 1908, the possibility of alleviating the manifestations of tetany through the intravenous infusion of calcium (Lebrun, De Block, & Jacquemyn, 2020).

However, the association between tetany and a drop in plasma calcium was only established experimentally in the following years as reported by Gao et al., (2019) (Gao, Li, Miao, & Lun, 2019). Two manuscripts mentioned that, in 1926, Lahey described the first case in which inadvertently resected or ischemic parathyroid glands were re-implanted in the neck muscles at the same operative time (Iorio et al., 2018; Mahmoud F Sakr, 2022b). The first large series of patients undergoing parathyroid re-implantation, with clinical, physiological and histological confirmation of the functioning of the grafts were demonstrated deeply by Macksey (2011) and Ziai et al., (2022) (Macksey, 2011; Ziai, Dixon, Berman, Campisi, & Wasserman, 2022).

**Operative technique**

Knowledge of the surgical anatomy of the thyroid is of fundamental importance in reducing the morbidity of this procedure. The location and anatomical variation of the recurrent laryngeal nerve, the external branch of the superior laryngeal nerve and the parathyroid glands must be well known by the surgeon (Freeman, Sewell, Hales, & Randolph, 2021; Gemsenjaeger, 2011; G.W. Randolph, 2020; Gregory W Randolph, Kamani, Wu, & Schneider, 2021; Sittel & Guntinas-Lichius, 2017; Tjahjono, Nguyen, Phung, Riffat, & Palme, 2021).

After individualization, the superior thyroid vessels are ligated very close to the superior pole of the thyroid, to avoid injury to the external branch of the superior laryngeal nerve. The middle thyroid vein is ligated next to the gland and, with this, the thyroid lobe is mobilized medially (Freeman et al., 2021; Gemsenjaeger, 2011; G.W. Randolph, 2020; Gregory W Randolph et al., 2021; Sittel & Guntinas-Lichius, 2017; Tjahjono et al., 2021). Meticulous dissection is performed in the tracheoesophageal groove, with visualization of the recurrent laryngeal nerve, until its penetration into the larynx. Particular attention should be paid to the parathyroid glands. The branches of the inferior thyroid artery must be ligated close to the thyroid capsule, avoiding devascularization of the parathyroids. Damage to the pedicle, hematoma or direct injury to the parathyroid gland implies its resection and its reimplantation in the neck musculature. The thyroid lobe is released from the trachea and then resected. After rigorous hemostasis, the median raphe, platysma and skin are closed (Freeman et al., 2021; Gemsenjaeger, 2011; G.W. Randolph, 2020; Gregory W Randolph et al., 2021; Sittel & Guntinas-Lichius, 2017; Tjahjono et al., 2021).

**Surgical anatomy of the parathyroid glands**

The parathyroids are small, oval-shaped endocrine glands, each measuring about 6 mm in length and 3 mm in width. They are usually found near the posterior surface of the thyroid (Oertli & Udelsman, 2012; G.W. Randolph, 2020). The identification of the parathyroid glands varies according to the operative technique, the underlying disease and the surgical difficulty. Some surgeons systematically locate all parathyroids during the operation (Oertli & Udelsman, 2012; G.W. Randolph, 2020). Anatomical studies show that 80.0% to 86.0% of the superior parathyroids and 90.0% to 95.0% of the inferior ones receive vascularization of the inferior thyroid artery (Mishra, Agarwal, Parameswaran, & Singh, 2022; Nistor et al., 2020).

Rarely, the superior thyroid artery is primarily responsible for supplying the superior parathyroid (0.6% on the right and 2.8% on the left). In 2.3% of the cases, the glands receive irrigation from the ima, laryngeal or esophageal thyroid arteries or from their anastomoses (Mishra et al., 2022; Nistor et al., 2020). The superior parathyroid gland is more frequently identified (69.0% of the cases) than the inferior (0% of cases), with no difference between sides (Mishra et al., 2022; Nistor et al., 2020). Normally, the human being has four parathyroids, this number varying, sometimes, from one to eight glands. In studies involving hundred patients, they found 0.9% of cases with a single gland, 2.0% with two, 7.6% with three, 85.3% with four and 4.2% with five or more glands (Alveryd, 1968; Rovena, Xheladin, Etmond, Leka, & Mitrushi; Sitges-Serra, Lorente-Poch, & Sancho, 2018).

Perioperative parathyroid viability is based on clinical assessment (gland staining). If blackened, it should be considered unfeasible and, consequently, resected and reimplanted. The surgeons suggest a small section of the gland capsule in cases of doubtful viability. When bleeding occurs, vascularization is probably preserved. They consider the clinical assessment of parathyroid viability based only on the gland color to be subjective, due to the possibility of different or even contradictory opinions regarding the same case. However, to date, there is no other more sensitive technique. (Mishra et al., 2022; Nistor et al., 2020; Oertli & Udelsman, 2012; G.W. Randolph, 2020).

**Activity of the parathyroid glands**

Each parathyroid gland functions individually and independently and, under normal conditions, has little or no proliferative activity. Even when broken down into fragments, they maintain hormone production (Bilezikian, Marcus, & Levine, 2001; Licata & Lerma, 2012; Peissig, Condie, & Manley, 2018; M.F. Sakr, 2022; Spartalis et al., 2020; Taterra et al., 2019). Each parathyroid has its point of regulation defined by the plasma concentration of calcium, and the release of PTH is unpredictable, varying from gland to gland. If one or more glands are resected, the remaining ones may or may not hyperplasia and, consequently, PTH production will gradually increase or remain insufficient (Bilezikian et al., 2001; Licata & Lerma, 2012; Peissig et al., 2018; M.F. Sakr, 2022; Spartalis et al., 2020; Taterra et al., 2019).

Normally, in states of chronic hypocalcemia and vitamin D deficiency, such as in renal failure, parathyroid cells multiply. The activity of the parathyroid glands varies by 50.0% during the 24 hours of the day and, consequently, both calcium and phosphorus show a daily variation from 0.2 mmol/l to 0.4 mmol/l. Several studies suggested standardizing the time for blood collection to minimize the impact of this variation on patient assessment (Bilezikian et al., 2001; Licata & Lerma, 2012; Peissig et al., 2018; M.F. Sakr, 2022; Spartalis et al., 2020; Taterra et al., 2019).

**Post-thyroidectomy complications**

The incidence of post-thyroidectomy complications has greatly decreased in recent years, but it still causes great inconvenience to patients (Alqahtani et al., 2020; Bawa et al., 2021; Pãduraru et al., 2019; Saleem, Saleem, & Saleem, 2018; Sidani, Islam, & Nwariaku, 2022). Postoperative hematoma, in general, occurs up to eight hours after the surgery, being rare after this period. It affects approximately 1.4% of thyroidectomized patients (Alqahtani et al., 2020; Bawa et al., 2021; Pãduraru et al., 2019; Saleem et al., 2018; Sidani et al., 2022).

The incidence of surgical wound infection varies from 0.0% to 2.7% of thyroidectomies and usually manifests itself from the fourth postoperative day onwards. As it is a clean operation, the infection results from poor asepsis technique or contamination of seromas or hematomas (Alqahtani et al., 2020; Bawa et al., 2021; Pãduraru et al., 2019; Saleem et al., 2018; Sidani et al., 2022).
According to recent published studies, temporary paralysis of the recurrent laryngeal nerve occurs in 0 .0% to 5.0% of patients undergoing their first thyroid operation (Alqahtani et al., 2020; Bawa et al., 2021; Pãduraru et al., 2019; Saleem et al., 2018; Sidani et al., 2022). Definitive paralysis has an incidence ranging from 0.0% to 3.1%, reaching 10.5% in reoperations (Freitas, Levenhagen, Constantino, Paroni, & Martins, 2020; Alvaro Sanabria et al., 2019). It should be considered, however, that in some cases, nerve preservation is not possible due to its involvement by the tumor. Injury to the external branch of the superior laryngeal nerve is probably underestimated, since vocal fold function and laryngeal vestibule sensitivity are not always analyzed pre- and postoperatively (Alqahtani et al., 2020; Bawa et al., 2021; Pãduraru et al., 2019; Saleem et al., 2018; Sidani et al., 2022).

Many times the clinical manifestations resulting from the lesion of this nerve are discreet, often going unnoticed. For this reason, the incidence found in the literature is so variable (0.3% to 58.0%) (Alqahtani et al., 2020; Bawa et al., 2021; Pãduraru et al., 2019; Saleem et al., 2018; Sidani et al., 2022).

**Postoperative hypocalcemia**

Hypocalcemia is the most frequent post-thyroidectomy complication (Pāduraru et al., 2019). According to McMurran et al., (2020) and Sessa et al., (2022) , post-thyroidectomy hypocalcemia is a complex phenomenon with multiple causes (McMurran, Blundell, & Kim, 2020; Sessa et al., 2022). Even if the parathyroid glands and their vascularization are preserved, hypocalcemia can occur (M.F. Sakr, 2022). Serum calcium appears in three forms: free or ionized (45.0%), bound to organic acid complexes (5.0%) and bound to proteins (50.0%). Ionic calcium is the metabolically active form, with important participation in biological functions such as neuronal activity, muscle contractility, hormone secretion and cell mitosis (Baldassarre, 2014).

The main mediator of calcium homeostasis is PTH. This is synthesized in the ribosomes of the parathyroid glands as pre-proparathyroid (115 amino acids), converted to proparathyroid (90 amino acids), transported through the rough endoplasmic reticulum and stored in secretory granules, as a mature hormone, with 84 amino acids (Gardella, Nissenson, & Jüppner, 2018; Hurjui et al., 2020). It is synthesized and secreted at a rate inversely proportional to the serum concentration of ionic calcium. Secretion is regulated by the interaction of extracellular calcium and specific receptors present on the surface of parathyroid cells(Gardella et al., 2018; Hurjui et al., 2020).

In addition to calcium (the main regulator), PTH synthesis is dependent on phosphorus and vitamin D. Increased phosphorus concentration can induce hypocalcemia, increasing PTH synthesis, while increasing vitamin D concentration inhibits the transcriptional activity of parathyroid cell genes, decreasing PTH synthesis(Gardella et al., 2018; Hurjui et al., 2020). In the kidneys, PTH increases calcium reabsorption in the tubules proximal and distal (normally the kidneys filter and reabsorb large amounts of calcium – 250 mmol/day), increases phosphorus excretion and stimulates the conversion of 25-hydroxycholecalciferol into vitamin D, which, in turn, acts on the bones (increasing resorption bone) and gastrointestinal mucosa (increasing calcium absorption) (Rifai, 2017; Stipanuk & Caudill, 2018).

In bones, PTH stimulates the release of calcium, increasing the activity and number of osteoclasts (Rifai, 2017; Stipanuk & Caudill, 2018). Fluctuations in serum calcium concentration cause rapid changes in PTH secretion, which, within minutes, interfere with tubular calcium reabsorption and osteoclast activity, increasing or decreasing bone resorption (Rifai, 2017; Stipanuk & Caudill, 2018). In contrast to this feed system -fast back, there is another, slower, adjustment of serum calcium, which occurs in one to two days and results from the action of vitamin D in the gastrointestinal tract, stimulating calcium absorption (Rifai, 2017; Stipanuk & Caudill, 2018).

Postoperatively, patients with hypoparathyroidism have deficient secretion of PTH and, consequently, loss of action of this hormone in bones and kidneys. Bone resorption and calcium release from skeletal stores are decreased. There is also a reduction in renal tubular reabsorption of calcium. However, due to hypocalcemia and low filterable load, urinary calcium excretion is low (Rifai, 2017; Stipanuk & Caudill, 2018).

PTH deficiency also determines a reduction in phosphate clearance, with hyperphosphatemia being a common finding. PTH deficiency and hyperphosphatemia prevent renal production of vitamin D, the low circulating level of which results in decreased intestinal calcium absorption and bone resorption. Thus, patients with postoperative hypoparathyroidism may develop hypocalcemia, hyperphosphatemia, hypomagnesemia and metabolic alkalosis (Rifai, 2017; Stipanuk & Caudill, 2018).

**Definition and clinical manifestations of hypocalcemia**

Hypocalcemia is defined as serum calcium concentration below the normal level (Acton, 2012). Reduction in total serum calcium may not reflect the reduction in ionic calcium, and, consequently, clinical manifestation may not occur (Acton, 2012). Due to the lack of PTH stimulation (PTH half-life is 3 to 5 minutes), blood calcium levels gradually decrease. Therefore, clinical manifestations usually appear in the first 24 to 48 hours after surgery, and they are infrequent before and after this period (Acton, 2012; P. Del Rio et al., 2019; di Filippo, Doga, Frara, & Giustina, 2021; Pepe et al., 2020).

In some patients, the manifestations of hypocalcemia are mild and sometimes imperceptible or absent. Some studies described up to 87% of asymptomatic hypocalcemia after total thyroidectomy in which a meticulous dissection of the parathyroid glands was performed (Barbier et al., 2022; Bove et al., 2020; Hanks & Inabnet, 2015; Marino & Sutin, 2012; Rajan et al., 2020) . These studies reported that 83.0% of thyroidectomized patients developed postoperative hypocalcemia, and 13.0% had signs and symptoms, requiring calcium replacement (Barbier et al., 2022; Bove et al., 2020; Hanks & Inabnet, 2015; Marino & Sutin, 2012; Rajan et al., 2020).

According to their findings, dosage of ionic calcium instead of total calcium increases the accuracy of the results, since patients with other comorbidities and malnourished patients may have hypoalbuminemia and, consequently, alterations in the serum concentration of total calcium (Barbier et al., 2022; Bove et al., 2020; Hanks & Inabnet, 2015; Marino & Sutin, 2012; Rajan et al., 2020). The adjustment of total calcium values based on the albumin concentration may not adequately reflect the ionic calcium concentration, as changes in pH, differences in the albumin-globulin ratio and magnesium concentration may alter these values (Barbier et al., 2022; Bove et al., 2020; Hanks & Inabnet, 2015; Marino & Sutin, 2012; Rajan et al., 2020) . Several studies suggested that ionic calcium levels alone are safe to investigate hypoparathyroidism and that ionic calcium levels can also be correlated with the clinical picture resulting from hypocalcemia, identifying patients at risk (Abdelhamid & Moussa, 2020; Laft, Jawad, & Numan; Thachil, Joseph, & David, 2021).

Classic manifestations of hypocalcemia result from neuromuscular junction hyperexcitability and include: paresthesia or tingling around the mouth, hands and/or feet, myalgia, tachycardia, lethargy, irritability, seizures, laryngospasm or bronchospasm, QT interval prolongation on electrocardiogram, arrhythmias and even death (Abdel-Aziz, Elfeky, & AboSeda, 2018; Jacoby, 2020; NUMBNESS, 2018; Root & Levine, 2021). Allgrove and Shaw (2015) and Mutahar 2020) associated serum calcium levels with the presence and severity of signs and symptoms, and the acute drop in calcium levels can lead to a more exuberant clinical picture (Allgrove & Shaw, 2015; Mutahar, 2020).

Trousseau's and Chvostek's signs allow demonstrating the existence of latent tetany (Brunner, Smeltzer, Bare, Hinkle, & Cheever, 2010; Busch, Bradley, & Guardiola, 2022; Figueiredo & Joliat, 2020). Chvostek's sign is investigated by percussion of the facial nerve in its path, anterior to the pinna, and in cases of hypocalcemia, contraction of the ipsilateral perilabial muscles is observed (Omerovic, 2019; Singer & Terris, 2021; Vakharia & Topor, 2021). This sign can be positive in up to 10.0% of normal people (Omerovic, 2019; Singer & Terris, 2021; Vakharia & Topor, 2021).

Trousseau's sign is more specific and consists of the observation of generalized contraction of the forearm muscles and wrist flexion after application, for 3 minutes, of the sphygmomanometer with a pressure of about 20 mmHg above the systolic pressure (Dennis, Bowen, & Cho, 2012; Mistry & Rao, 2021; M. Patel & Hu, 2020; Schnur, Sinawe, Yoham, & Casadesus, 2021). The clinical signs and symptoms described are suggestive of hypocalcemia, and laboratory confirmation is made by measuring ionic calcium. The confirmation of hypoparathyroidism is laboratory, demonstrating undetectable blood concentrations of PTH or below the normal level (Dennis et al., 2012; Mistry & Rao, 2021; M. Patel & Hu, 2020; Schnur et al., 2021).

**Classification of hypocalcemia**

Hypocalcemia is classified as transient and permanent (Qin et al., 2021). Transient hypocalcemia (symptomatic or not) occurs when calcium levels return to normal within six months postoperatively (Stack & Bodenner, 2016). It is seen in 1.3% to 83.0% of cases. According to several studies, mild to moderate transient hypocalcemia can occur both after thyroidectomies and in other operations such as neck dissection and abdominal operations, often without PTH decline (Mercante et al., 2019; Philips et al., 2019; Stack & Bodenner, 2016; Unsal et al., 2020). It is usually associated with hemodilution. Postoperative hypocalcemia is usually a benign condition and does not predict permanent hypoparathyroidism (Mercante et al., 2019; Philips et al., 2019; Stack & Bodenner, 2016; Unsal et al., 2020).

Definitive hypoparathyroidism occurs when the patient maintains PTH levels below normal for a period longer than six months, requiring oral calcium administration (Bruno et al., 2021; Díez et al., 2020). Some authors still divide it into chronic hypocalcemia (persistence after six months) and definitive (after one year) (Ram, Khan, & Aziz; Alvaro Sanabria, Kowalski, & Tartaglia, 2018; Teisseyre, Moranne, & Renaud, 2021).

Permanent functional hypoparathyroidism is defined by the need for oral calcium administration to a patient with apparently normal PTH levels (E. Kim, Ramonell, Mayfield, & Lindeman, 2021; Sitges-Serra, 2021). Obiarinze et al., (2021) believes that there may be normalization of parathyroid function up to two years after thyroidectomy (Obiarinze, Fazendin, Iyer, Lindeman, & Chen, 2021). Definitive hypoparathyroidism occurs in 0.0% to 33.0% of patients undergoing thyroidectomy (Díez et al., 2021; Linos & Chung, 2012).

Two studies showed the incidences of transient hypocalcemia and definitive hypoparathyroidism after total thyroidectomy and after different types of thyroidectomies, according to different authors(Díez et al., 2021; Linos & Chung, 2012).With their findings, the divergences of the studies in relation to the calcium dosage (ionic or total) used in the evaluation of hypocalcemia can be observed (Díez et al., 2021; Linos & Chung, 2012).

**Factors related to hypocalcemia**
**Gender and age**

Del Rio et al., (2019), as well as other authors, showed that there is no influence of patient gender on the onset of postoperative hypocalcemia (P. Del Rio et al., 2019; Palmhag, Brydolf, Zedenius, Bränström, & Nilsson, 2021; Waseem et al., 2021). In contrast, Hamid et al., (2022), Marimuthu & Murugan, (2021) and Modi & Charpot, (2021) showed a significantly higher incidence of postoperative hypocalcemia in women (Hamid et al., 2022; Marimuthu & Murugan, 2021; Modi & Charpot, 2021). Regarding age, few authors report any difference between young and elderly patients (P. Del Rio et al., 2019; Mahmoud F Sakr, 2022d; Spinelli et al., 2022). Sakr et al., (2022) noted a higher incidence of post-thyroidectomy hypocalcemia in young women(Mahmoud F Sakr, 2022d).

**Extension of the surgical procedure**

The extent of the surgical procedure is directly related to the severity of hypocalcemia as well as its incidence, although minor operations can also lead to a drop in serum calcium (Butt, Fayyaz, Quratulain, & Sultan, 2022; Spinelli et al., 2022; Vasileiadis, Charitoudis, Vasileiadis, Kykalos, & Karatzas, 2018).

**Partial thyroidectomy**

After partial thyroidectomy (lobectomy + isthmectomy), hypocalcemia is relatively rare, with less clinical repercussion. It is usually asymptomatic, resolving in a few days (Kazaure et al., 2021). Kazaure et al., (2021) 7 found 0.4% of cases of hypocalcemia after partial thyroidectomy, 0.1% of which were definitive, in a series of 7366 patients. Reports in the literature on post-partial thyroidectomy hypocalcemia are divergent (Al Najjar, Ghoush, Elmajed, Eldimllawi, & Abousalha, 2021; Azaria, 2019; Mears & Treacy, 2020).

Many researchers identified 30.0% to 40.0% of patients with hypocalcemia among those undergoing partial thyroidectomy, with hypocalcemia being symptomatic in 7.0% of them (Al Najjar et al., 2021; Azaria, 2019; Mears & Treacy, 2020). In these cases, hypocalcemia is not specific and may be related to hemodilution, hypothermia, hypoalbuminemia, decreased tubular reabsorption of calcium and increased release of calcitonin, which can be observed in other types of surgery (Al Najjar et al., 2021; Azaria, 2019; Mears & Treacy, 2020).

According to Rahim et al., (2021), hemodilution and changes in albumin or bicarbonate levels are not factors related to hypocalcemia (Rahim et al., 2021). Guo et al., (2021) and Palop et al., (2021) widely believe that postoperative hypocalcemia in patients undergoing partial thyroidectomy is due to reduced renal tubular reabsorption of calcium, and it is unlikely that PTH and calcitonin are responsible for this renal change (Guo, Zhao, Xie, Yan, & Mo, 2021; Palop, Martínez, Giménez, Samper, & Fuster, 2021).

On the other hand, four recent published studies observed a significant decrease in total calcium levels compared to the preoperative period, with ionic calcium remaining stable, as well as a decrease in albumin, but without changes in PTH and calcitonin (G. Lombardi, Ziemann, Banfi, & Corbetta, 2020; Mohamed, Qureshi, & Mohamed, 2020; Mahmoud F Sakr, 2020; Winter & Harris, 2021).

The PTH level may, in some cases, decrease in the postoperative period of partial thyroidectomy. In these cases, the most accepted explanation is the decrease in PTH release by the parathyroids, which are suppressed by manipulation (G. Lombardi et al., 2020; Mohamed et al., 2020; Mahmoud F Sakr, 2020; Winter & Harris, 2021). Bobanga & McHenry, (2021) and Patel et al., (2020) and Sakr, (2022) found 85.0% of cases of decreased PTH levels in the postoperative period, 73.0% of which underwent partial thyroidectomy, suggesting high sensitivity of the parathyroid glands to manipulation (Bobanga & McHenry, 2021; K. N. Patel et al., 2020b; Mahmoud F Sakr, 2022e). They showed a drop in PTH after all thyroidectomies, partial or total, with greater impact in larger operations, but this fact was not associated with clinical manifestations of hypocalcemia.

**Total thyroidectomy**

After total thyroidectomy, the incidence of postoperative transient hypocalcemia ranged from 8.9% to 53.0%, with 0.0% to 25.0% of definitive cases (Mercante et al., 2019; Weng et al., 2021). Philips et al., (2019) and Sakr, (2020) showed a reduction in calcium levels in the postoperative period compared to the preoperative period in all patients undergoing total thyroidectomy, with 13.0% requiring calcium replacement (Philips et al., 2019; M.F. Sakr, 2020).

There was also an increase in phosphorus levels in patients who required calcium replacement, while magnesium ion remained unchanged, suggesting hypoparathyroidism (Philips et al., 2019; M.F. Sakr, 2020). Akdeniz & Avcı, (2021), Masood et al., (2019) and Sumukha, (2020) suggested total thyroidectomy, instead of subtotal thyroidectomy, as the treatment of choice for multinodular goiter with surgical indication, since there was no statistically significant difference in relation to late complications (Akdeniz & Avcı, 2021; Masood, Kanaan, & Khaddouj, 2019; Sumukha, 2020).

There was a higher incidence of temporary hypoparathyroidism after total thyroidectomy, but, on the other hand, more frequent recurrence of goiter after subtotal thyroidectomy. In this case, reoperation had a higher rate of both temporary and permanent complications. Van Slycke et al., (2021) and Lorenz et al., (2020) found no statistically significant differences in relation to total thyroidectomy and other thyroidectomies (Kerstin Lorenz, Raffaeli, Barczyński, Lorente-Poch, & Sancho, 2020; Van Slycke, Van Den Heede, Bruggeman, Vermeersch, & Brusselaers, 2021).

**Subtotal thyroidectomy**

In the postoperative period of ST (lobectomy + isthmectomy + contralateral partial lobectomy), the incidence of transient hypocalcemia ranged from 5.0% to 29.0% and that of permanent hypocalcemia ranged from 0.0% to 2.3% (Boutzios et al., 2019; Gunn, Oyekunle, Stang, Kazaure, & Scheri, 2020; Kazaure et al., 2021).

According to Brophy et al., (2019) and Pepe et al., (2020), post- subtotal thyroidectomy hypocalcemia has temporary hypoparathyroidism as its main cause (Brophy, Woods, Murphy, & Sheahan, 2019; Pepe et al., 2020). Bilateral subtotal thyroidectomy, in which part of the thyroid lobe is bilaterally preserved, is associated with an increase in goiter recurrence by 9.0% to 43.0% and with an increase in surgical morbidity in the need for reoperation (Y. S. Kim et al., 2020; G.W. Randolph, 2020; Sehnke, Schwarz, & Goretzki, 2018).

**Reoperation**

Reoperation has high complication rates compared to the first surgical procedure. The main indications for reoperation are: resection of the thyroid remnant in cancer patients; recurrent thyroid carcinoma; tumor recurrence in recurrent chain lymph nodes; recurrent goiter in symptomatic patients; recurrent thyrotoxicosis; and aesthetics (Dobrinja et al., 2021; Jukic, 2017; Kazaure et al., 2021; H. K. Kim, Ha, Han, Lee, & Soh, 2020; Margolick, Chen, & Wiseman, 2018; Semrad, Keegan, Semrad, Brunson, & Farwell, 2018).

The incidence of transient hypocalcemia varies from 3.0% to 44.1% and that of permanent hypocalcemia, from 0.0% to 11.0%. According to several studies, reoperation increases the risk of iatrogenic injury to the parathyroids by ten times (Dobrinja et al., 2021; Jukic, 2017; Kazaure et al., 2021; H. K. Kim et al., 2020; Margolick et al., 2018; Semrad et al., 2018).

Inflammatory process, bleeding, tissue friability and adhesion of structures are factors that make reoperation technically more difficult and with higher rates of complications. Therefore, it should be performed in the first postoperative days, still during the same hospitalization, or three to four months later (Dobrinja et al., 2021; Jukic, 2017; Kazaure et al., 2021; H. K. Kim et al., 2020; Margolick et al., 2018; Semrad et al., 2018).

**Neck dissection**

Of the patients with papillary carcinoma (PC) of the thyroid, 70.0% to 90.0% have microscopic metastasis in regional lymph nodes (recurrent chain) (H. K. Kim et al., 2020). Of those who do not undergo recurrent dissection, 7.0% to 15.0% develop clinically detectable metastasis, despite surgical treatment (total thyroidectomy) associated with radioactive iodine ablation (Mancino & Kim, 2017). More recently, contrary to what was previously thought, it has been suggested that the presence of lymph node metastasis alters the prognosis, exerting an important influence on patient survival and the rate of disease recurrence (Russell, Inabnet, & Tufano, 2020).

The biggest discussion in relation to elective dissection or not of the recurrent chain is based on its morbidity, especially with regard to definitive postoperative hypoparathyroidism (Mallick & Harmer, 2018). According to Yan et al., (2021), Luster et al., (2019) and Mandapathil et al., (2019), recurrent neck dissection is associated with a higher incidence of postoperative hypoparathyroidism, ranging from 14.0% to 54.6% (transient) and from 4.0% to 17 .4% (definite), and also the higher incidence of inadvertent parathyroid resection (Luster, Duntas, & Wartofsky, 2019; Mandapathil, Lennon, Ganly, Patel, & Shah, 2019; Yan, Xiang, Wang, & Wang, 2021).

Chang et al., (2020), Godlewska et al., (2020) and Terris & Duke, (2016), in which 4.0% of the patients developed definitive hypoparathyroidism, suggest that recurrent dissection is not routinely performed in all cases of PC, but only in those with clinically detectable metastases or in patients at higher risk (Chang et al., 2020; Godlewska et al., 2020; Terris & Duke, 2016).

**Identification of the parathyroid glands and reimplantation**

The relationship between the number of identified parathyroid glands and the incidence and/or severity of hypocalcemia is controversial (M.F. Sakr, 2020). Van Slycke et al., (2021) and Falch et al., (2018) stated that the incidence of temporary hypocalcemia is inversely proportional to the number of parathyroid glands found (Falch et al., 2018; Van Slycke, Van Den Heede, Brusselaers, & Vermeersch, 2021). On the other hand, Del Rio et al., (2019), Sakr, (2022) and Mencio et al., (2020) did not find any correlation between these two factors (P. Del Rio et al., 2019; Mencio et al., 2020; Mahmoud F Sakr, 2022d).

According to Ponce de León-Ballesteros et al., (2019), Sitges-Serra, (2021) and Sakr, (2022a), in situ preservation of at least one parathyroid gland is the main way to prevent hypocalcemia, with a reduction in definitive hypoparathyroidism to less than 5.0% (Ponce de León-Ballesteros et al., 2019; Mahmoud F Sakr, 2022b; Sitges-Serra, 2021).

Inadvertent resection of the parathyroid gland occurs between 1.0% and 19.0% of thyroidectomies, all of which confirm that there is no relationship between this resection and postoperative hypocalcemia when only one gland is resected and the others remain intact, with the preserved pedicle (Levine, 2018; Rajamahendran, 2018). Lee et al.78 found an incidence of 11.0% of inadvertent resection in their series of hundred patients, and in 2.0% of the cases, the gland in question was intrathyroid (S. H. Kim et al., 2020; Yao et al., 2022).

No patient evolved with permanent hypoparathyroidism. Bai et al., (2018), Ghafoor et al., (2020) and Sala et al., (2019) showed a higher incidence of inadvertent parathyroid resection in cases of reoperation and neck dissection, with no correlation with the histological type of the disease or the size of the thyroid gland (Bai, Chen, & Chen, 2018; Ghafoor et al., 2020; Sala et al., 2019). According to Tsai et al., (2019) and Sakr, (2022b) the resection of two or more glands has proven to increase the risk of transient and permanent postoperative hypoparathyroidism (Mahmoud F Sakr, 2022d; S.-H. Tsai et al., 2019).

According to Parameswaran & Agarwal, (2018) and Myers & Snyderman (2017), when three or more parathyroid glands were identified and preserved in situ, all patients who developed postoperative hypocalcemia returned to preoperative calcium levels (Myers & Snyderman, 2017; Parameswaran & Agarwal, 2018). Lesions of the vascular pedicle of the parathyroids can occur due to tension at the time of ligation of the thyroid vessels or by their inclusion in the ligation. Damage to the parathyroid veins can lead to congestion of the gland and temporarily interfere with its function (Myers & Snyderman, 2017; Parameswaran & Agarwal, 2018).

The best way to preserve the vascularization of the parathyroid glands is the juxtacapsular dissection of the thyroid gland, with ligation of the branches of the inferior thyroid artery close to the thyroid(Myers & Snyderman, 2017; Parameswaran & Agarwal, 2018). At the end of the operation, the thyroid bed and resected thyroid should be thoroughly evaluated looking for inadvertently resected or ischemia parathyroid, which, if found, should then be reimplanted into the neck musculature (usually the sternocleidomastoid muscle) (Myers & Snyderman, 2017; Parameswaran & Agarwal, 2018).

It is fragmented and crushed before being implanted, in order to increase the contact surface with the recipient bed and, consequently, the chance of graft success and the return of its function. Implantation of a devascularized or resected parathyroid gland inadvertently can reduce the incidence of permanent hypoparathyroidism (Myers & Snyderman, 2017; Parameswaran & Agarwal, 2018). If there are signs of venous congestion or hemorrhage in the parathyroid gland, it is necessary to decompress it, incising its capsule (Myers & Snyderman, 2017; Parameswaran & Agarwal, 2018).

According to Barczyński et al., (2017), the parathyroid tissue, implanted in the muscle, is initially nourished by imbibition, starting to receive new vascularization after five or six days, when capillaries grow in the periphery of the gland (Barczyński, Gołkowski, & Nawrot, 2017). After two to three weeks, vascular connections are established between the parathyroid and the body (Barczyński et al., 2017). Three studies showed the functioning of all parathyroid grafts 15 days after surgery (Lo & Tam, 2001; Ponce de León-Ballesteros et al., 2019; Sierra et al., 1998). The percentage of graft take-up varies from 83.0% to 95.0% (Lo & Tam, 2001; Ponce de León-Ballesteros et al., 2019; Sierra et al., 1998). Jung et al., (2013) and Chen et al., (2022) indicated that, although the percentage of return to function of the parathyroid graft is high when the four glands are implanted, the PTH level reaches, at most, 70.0% of the preoperative values (C.-F. Chen et al., 2022; Jung et al., 2013).

When at least one gland is left in the bed, with a preserved pedicle, the PTH reaches at least 80.0% of the preoperative value (C.-F. Chen et al., 2022; Jung et al., 2013). Several implantation methods have been proposed - the glands can be crushed, minced, sliced, injected or implanted whole - the most accepted being the use of small slices, approximately 0.3 mm (Nasiri et al., 2022; Mahmoud F Sakr, 2022b). The implantation areas commonly described are the neck muscles (mainly sternocleidomastoid), pectoral or forearm musculature. Most authors prefer the neck muscles, taking advantage of the same incision. In cases with the possibility of neck dissection in the future, with risk of resection of the muscle used for implantation, a parathyroid graft is chosen in the pectoral or forearm muscles (Nasiri et al., 2022; Mahmoud F Sakr, 2022b).

**Surgeon experience**

Many authors state that the incidence of postoperative hypocalcemia is inversely proportional to the surgeon's experience (Ceylan & Kesici, 2022; Remer, Linhares, Scola, Khan, & Lew, 2022; Sessa et al., 2022). The surgeon's experience is not an independent predictive factor, and the surgical extension alone , the most important predictive factor. Operations performed by residents under the supervision of experienced surgeons did not have an increased incidence of postoperative hypocalcemia (Ceylan & Kesici, 2022; Remer et al., 2022; Sessa et al., 2022)

**Thyroid disease**

According to several authors, thyroid disease is related to an increased incidence of hypocalcemia (Jagadeesan, 2020; Rivera & Lock, 2008; Suh & Shen, 2016). Diving goiter, thyroid cancer, hyperthyroidism (diffuse or multinodular toxic goiter), and bulky goiter increase the postoperative incidence of hypocalcemia (JM & NM, 2004). On the other hand, Hemmati et al., (2021), Cali et al., (2021), Brophy et al., (2019) and Grodski & Serpell, (2008) found no statistically significant difference in the relationship between diagnosis of the underlying disease and post-thyroidectomy hypocalcemia (Brophy et al., 2019; Cali, Hasani, Buffet, Menegaux, & Chereau, 2021; Grodski & Serpell, 2008; Hemmati et al., 2021).

**Thyroid volume**

Few authors relate thyroid volume to postoperative hypocalcemia (Richa, Issa, Echtay, & El Rawas, 2018; S.-Q. Xu, Ma, Su, Cheng, & Zhou, 2019). Prete et al., (2022) and Papanastasiou et al., (2019)  suggest that the assessment of thyroid volume can be performed preoperatively by ultrasonography. In their studies, massive goiter was associated with longer operative time and greater blood loss and, consequently, with a higher incidence of hypocalcemia (Papanastasiou et al., 2019; Prete et al., 2022).

**Thyroid Carcinoma**

In studies conducted by Wanget al., (2021) and Bumber et al. (2020), thyroid carcinoma was the main predictive factor for the development of postoperative hypocalcemia (Bumber, Potroško, Vugrinec, Ferenčaković, & Gršić, 2020; C. WANG et al., 2021). Bjornsdottir et al., (2022), Lim et al., (2020), and Beahrs and

Ahn et al., (2019) reported a high incidence (3.0% to 6.5%,) of definitive hypoparathyroidism after thyroidectomy for cancer (Ahn et al., 2019; Bjornsdottir et al., 2022; Díez et al., 2019; Lim, Jeon, Gwak, & Suh, 2020).

Transient post-thyroidectomy hypocalcemia for cancer ranged from 12% to 20% in most series, reaching 75.0% in some studies exhibited substituting goiter (Hamdan, Sataloff, & Hawkshaw, 2020; Mallick & Harmer, 2018). They showed, in multivariate logistic regression analysis, that substernal goiter is an independent predictive factor for postoperative hypocalcemia (Hamdan et al., 2020; Mallick & Harmer, 2018).

**Hyperthyroidism and Hypothyroidism**

Thyroid hormone acts on the bones primarily by increasing the rate of bone remodeling and, simultaneously, the fecal and urinary excretion of calcium and the reabsorption of phosphorus (Delitala, Scuteri, & Doria, 2020; Lademann, Tsourdi, Hofbauer, & Rauner, 2020; Shi et al., 2020; Tsourdi, Lademann, & Siggelkow, 2018). In the bones of hyperthyroid patients, there seems to be greater activity of osteoclasts in relation to of osteoblasts and, consequently, greater resorption than bone neoformation (Delitala et al., 2020; Lademann et al., 2020; Shi et al., 2020; Tsourdi et al., 2018).

Prolonged untreated hyperthyroidism can lead to osteodystrophy and, consequently, to post-total thyroidectomy hypocalcemia, due to rapid recalcification (bone starvation) due to the loss of hormone stimulus from thyroid (Delitala et al., 2020; Lademann et al., 2020; Shi et al., 2020; Tsourdi et al., 2018). This situation is confirmed by the high levels of alkaline phosphatase resulting from osteoblastic activity and bone formation in patients with postoperative tetany (Delitala et al., 2020; Ibrahim & Anumahb, 2021; Kusuki & Mizuno, 2019; Lademann et al., 2020; Shi et al., 2020; Tsourdi et al., 2018).

A recent study found higher levels of PTH in the preoperative period of patients with thyrotoxicosis, associating them with hypocalcemia (Abdelaziz, Essawy, Wageh, Khalifa, & Zydan, 2021). The use of antithyroid drugs leads, in a few months, to a significant recovery of bone density in patients with thyrotoxicosis, reducing the incidence of post-thyroidectomy hypocalcemia (Abdelaziz et al., 2021; Sywak, Prichard, & Delbridge, 2021; Testa, Martinelli, & Pacini, 2018a, 2018b).

Bugălă et al., (2022), Palmhag et al., (2021), Soylu & Teksoz, (2020) ,Thakur, (2021) and Şahbaz et al., (2018) considered hyperthyroidism, in multivariate logistic regression analysis, as an independent predictive factor for both transient and permanent postoperative hypocalcemia (Bugălă et al., 2022; Palmhag et al., 2021; Şahbaz et al., 2018; Soylu & Teksoz, 2020; THAKUR, 2021).

The incidence of symptomatic hypocalcemia in patients with Basedow-Graves disease (GD) was 50.0% for those clinically treated and 43.0% for those not treated, with no statistical difference between them (Bugălă et al., 2022; Palmhag et al., 2021; Şahbaz et al., 2018; Soylu & Teksoz, 2020; THAKUR, 2021). In contrast, Donahue et al., (2021) did not consider hyperthyroidism as a predictive factor for postoperative hypocalcemia, but empirically treated all patients postoperatively with calcium carbonate and/or vitamin D (Donahue, Pantel, Yarlagadda, & Brams, 2021). Phookan et al., (2021), Moran et al., (2020) and Wojtczak et al., (2018) commented that toxic goiter, as it is more vascularized, contributes to increased perioperative bleeding, reducing the visibility of the surgical field (Moran et al., 2020; Phookan et al., 2021; Wojtczak, Aporowicz, Kaliszewski, & Bolanowski, 2018).

According to Ismailov & Khayitboyeva, 2019) and Kh, (2019), this fact justifies a higher incidence of iatrogenic injury to the parathyroid glands. In addition, parathyroid vessels may be compromised by the autoimmune process of diffuse toxic goiter (Ismailov & Khayitboyeva, 2019; Kh, 2019).

Sakr, (2022) showed that the incidence of postoperative hypocalcemia was significantly higher in women with diffuse toxic goiter (Mahmoud F Sakr, 2022e). This greater predisposition of women to postoperative hypocalcemia can be partially explained by the fact that many of them have preoperative osteodystrophy, as a result not only of hyperthyroidism but also of osteoporosis (more frequent in postmenopausal women). However, there was a higher incidence of symptomatic hypocalcemia in young women, justified by the faster bone metabolism in female patients with thyrotoxicosis (Al Ibrahimi & Ahmed, 2021; Guo et al., 2021). This contribution was also pointed out by Eltyeb (2021), in 2021 (Eltyeb, 2021).

More recently, another study showed a statistically significant difference in relation to the concentration of 25 hydroxycholecalciferol - lower in women (2.38 nmol/l) than in men (3.30 nmol/l) – and concluded that the main cause of post-thyroidectomy hypocalcemia in women with diffuse toxic goiter is vitamin D deficiency (D. Kim, 2017). Less dramatic changes were seen with men. Hypothyroidism is also a cause of hypocalcemia (Tecilazich, Formenti, Frara, Giubbini, & Giustina, 2018). As the thyroid hormone participates in the renal activation of vitamin D, hypothyroidism can reduce its concentration, consequently leading to a decrease in intestinal absorption and an increase in calcium excretion (Tecilazich et al., 2018; Vibhatavata et al., 2020).

## Ligation of the inferior thyroid artery

Ligation of the inferior thyroid artery away from the thyroid gland is controversial, although many authors consider it a risk factor for transient and permanent hypoparathyroidismc (Alvaro Sanabria et al., 2018; Waseem et al., 2021). Waseem et al., (2021) and Ahmed et al., (2020) managed to significantly reduce the incidence of permanent hypoparathyroidism. in their patients after modifying their operative technique, starting to connect the branches of the inferior thyroid artery very close to the thyroid capsule (Ahmed, Waseem, Zafar, & Abid, 2020; Waseem et al., 2021).

Santrac & Dzodic, (2019), Sapmaz & Kılıç, (2020) and Al Kordy et al., (2019) found no statistically significant difference between ligation of the trunk and branches of the inferior thyroid artery close to the thyroid capsule (Al Kordy, El Ewesy, & Hassan, 2019; Santrac & Dzodic, 2019; Sapmaz & Kılıç, 2020).

Srinivasan et al., (2022) and Kong et al., (2019) suggested that anastomoses between branches of this artery and branches from the trachea, esophagus and thyroid maintain the vascularization of the parathyroid glands (Kong, Wang, & Wang, 2019; Srinivasan et al., 2022).

## Calcitonin

Calcitonin, a polypeptide consisting of 32 amino acids, is synthesized by the parafollicular cells of the thyroid gland (Giannetta et al., 2020; Shen, Wu, Zhang, & Tu, 2022). It induces a decrease in calcemia, inhibiting bone resorption by osteoclasts and increasing renal excretion of this ion (Xie et al., 2020). The regulation of calcitonin secretion is mainly done by the plasma concentration of calcium. Acute elevation or reduction of calcium levels leads, respectively, to an increase and decrease in calcitonin secretion (Hsiao et al., 2020; Xie et al., 2020). Although other factors have been described as stimulating calcitonin secretion, pentagastrin (mainly) and the administration of venous calcium are true secretagogues, being important agents for the clinical evaluation of calcitonin secretion by normal and neoplastic cells (Wondisford, 2020; Wong, Nabata, & Wiseman, 2022).

Some authors suggested that calcitonin is also responsible for the alteration of the postoperative calcium concentration in thyroidectomies (Băetu, Olariu, Nițu, et al., 2021; Băetu, Olariu, Stancu, et al., 2021; Tausanovic et al., 2021). Manipulation of the thyroid gland would lead to an increase in calcitonin secretion and, consequently, to a decline in calcium. The effect of calcitonin is expected early, as its half-life is two to 15 minutes (P. Yu et al., 2019). Li et al., (2021), Hamed & Afifi, (2019) and Sharif et al., (2018) showed that there was no significant change in postoperative calcitonin when comparing patients with hypo- or normocalcemia (Hamed & Afifi, 2019; Li, Rogers, & Rehman, 2021; Sharif, Ali, Rahman, Siddique, & Rahman, 2018).

In healthy volunteers, administration of calcitonin did not cause hypocalcemia. Chin et al., (2004) and Del Rio et al., 1987) reported a slight increase in plasma calcitonin levels in the first two postoperative days, as well as a decrease in calcium, concluding, however, that as this decrease preceded the increase in calcitonin, there was no correlation between the two findings (Chin, Gutierrez, Still, & Kosutic, 2004; A. Del Rio, Rico, Bordiu, & Novoa, 1987). Oliveira et al.,( 2021) detected a reduction in calcitonin levels after thyroidectomy (Oliveira et al., 2021).

## Hypoalbuminemia and blood transfusion

Qu et al., (2022), (Tinawi, 2021) and Cornelius, (2020) suggested that hypoalbuminemia may be the main factor in the pathogenesis of postoperative hypocalcemia, when only total calcium is measured. Patients receiving blood transfusions during or after the operation may have hypocalcemia (Cornelius, 2020; Qu, Wang, & Li, 2022; Tinawi, 2021). Citrate, used for blood conservation, chelates calcium, reducing the concentration of ionic calcium (Cornelius, 2020; Zulkufli, Jamaluddin, & Yazid, 2020).

**Drug and fluid administration**

Drugs and intravenous fluids can also alter calcium levels. Thiazide diuretics, vitamins A and D, lithium, and antacids may induce hypercalcemia (Bateman & Egan, 2022; Wermers & Abate, 2022), while anticonvulsants, diazepines, oral contraceptives, and steroids may favor hypocalcemia (Onset, 2019; Springer & Nappe, 2019). Rajeswari, (2017) did not, however, find a correlation between the ingestion of these drugs and the administration of fluids in the peri- and postoperative periods with the development of transient or permanent hypocalcemia (Rajeswari, 2017).

Reddy & Mohammad, (2022)and Chang et al., (2020) in a comparative study between thyroidectomies and other surgical procedures in the neck, showed that hemodilution and parathyroid dysfunction are involved in the fall in calcium (Chang et al., 2020; Reddy & Mohammad, 2022). In the perioperative period of these operations, it was mainly caused by hemodilution, while hypoparathyroidism was the main responsible for its occurrence in the postoperative period of thyroidectomies (Chang et al., 2020; Reddy & Mohammad, 2022).

According to Kandinov et al., (2021), comparing operations such as parotidectomy, laryngectomy and cholecystectomy with thyroidectomies, showed a slight decrease in total calcium in all procedures, but ionic calcium remained stable (Kandinov, Nguyen, Yuhan, Johnson, & Svider, 2021).

**Urinary alteration**

According to several studies conducted by different authors, variation in urinary calcium concentration was not different when comparing thyroidectomized patients with those undergoing other procedures (Edafe, Mech, & Balasubramanian, 2019; Mazoni et al., 2022; Nemade, Rokade, Pathak, Tiwari, & Sonkhedkar, 2014; Ponce de León-Ballesteros et al., 2020). The authors found that calciuria decreased after all procedures, returning to preoperative values on the second day after surgery.

**Calcium cut-off value**

Some studiesusing postoperative calcium measurements were able to predict which patients might or might not develop hypocalcemia manifestations (Mallick & Harmer, 2018; Pãduraru et al., 2019; Saint & Chopra, 2018; M.F. Sakr, 2022; Spartalis et al., 2019). Some researchers had verified, through serial measurements of postoperative calcium, that a calcium curve that is always positive in the first 14 hours after the operation predicts, 100% of the time, that the patient will remain normocalcemic, and can be safely discharged from the hospital, no risk of hypocalcemia (Mallick & Harmer, 2018; Pãduraru et al., 2019; Saint & Chopra, 2018; M.F. Sakr, 2022; Spartalis et al., 2019). The others also showed that early calcium measurements (12 hours postoperatively) may foreshadow symptomatic postoperative hypocalcemia (Malik et al., 2019; Sasi et al., 2022; Torabi, Avery, Salehi, & Lee, 2020).

In two studies carried out by Essa et al., (2021) and Vasudev & AV, (2020), the calcium curve that was always positive or initially negative and later positive in the first 24 hours after surgery indicated a low probability of manifestations of hypocalcemia (Essa et al., 2021; Vasudev & AV, 2020). Vasudev & AV, (2020) concluded that a stable or rising calcium curve ensures safety for patients undergoing total thyroidectomy on the first postoperative day to be discharged, as they do not present a risk of hypocalcemia (Vasudev & AV, 2020).

On the other hand, a declining calcium curve does not necessarily imply the appearance of clinical manifestations of hypocalcemia, but the patient should be considered at risk and, therefore, remain hospitalized under observation. McLeod et al., (2006) reported that patients with a positive calcium curve (12-hour calcium value minus 6-hour calcium value) have an 87.5% chance of remaining normocalcemic. In contrast, a negative calcium curve predicts hypocalcemia in 46.2% of cases (McLeod et al., 2006). Curves greater than +0.02 mmol/l/hour have a significantly high chance of predicting normocalcemia (97.0%), while values equal to 0.00 mmol/l/hour can predict it 78% of the time.

Patel et al.,(2020) and Del Rio et al., (2019) confirmed that patients with total calcium below 7.5 mg/dl have a high risk of becoming symptomatic, unlike those with calcium above this value (P. Del Rio et al., 2019; K. N. Patel et al., 2020a). Del Rio et al., (2019) and Bergamaschi et al., (1998) showed an incidence of temporary and permanent hypocalcemia, respectively, according to postoperative calcium values: 14.9% and 2.1% for calcium concentrations below 1.60 mmol/l; 4.1% and 1.1% for calcium between 1.60 and 1.80 mmol/l; and 0.8% and 0.5% for calcium between 1.80 and 2.00 mmol/l, considering calcium reference values from 2.25 mmol/l to 2.60 mmol/l (Bergamaschi, Becouarn, Ronceray, & Arnaud, 1998; P. Del Rio et al., 2019).

Paladino et al., (2021) showed that ionic calcium values below 2.00 mmol/l (2.25 mmol/l to 2.60 mmol/l) on the first postoperative day can predict hypocalcemia manifestations by approximately 50.0 % of cases (Paladino et al., 2021). According to Noordzij et al., (2007) and Richards et al., (2003), measuring ionic calcium at six hours and also one day after surgery, found a value of 1.00 mmol/l (1.12 mmol/l to 1.32 mmol/l) or less for symptomatic patients. At six hours and one day after the operation, respectively, the sensitivity of the test was 40.0% and 50.0%; the specificity of 94.0% and 79.0%; the positive predictive value of 80.0% and 56.0%; and the negative predictive value of 74.0% and 75.0% (Noordzij et al., 2007; Richards, Bingener-Casey, Pierce, Strodel, & Sirinek, 2003).

Mahmoud F Sakr, (2022), Noordzij et al., (2007) and (Lombardi et al., 2004) found a statistically significant decrease in calcium values in the postoperative period compared to the preoperative period, noting that, in normocalcemic patients, it tends to stabilize after six hours of the operation, while, in hypocalcemic patients, the decline is progressive, up to approximately 42 hours postoperatively (C. P. Lombardi et al., 2004; Noordzij et al., 2007; Mahmoud F Sakr, 2022d). On the other hand, Wang et al., (2015) and Albert Stepansky et al., (2010), performing serial calcium measurements, were unable to define whether or not patients would develop hypocalcemia (Albert Stepansky, Natan Poluksht, Philippe Hagag, & Ilan Wassermann, 2010; J.-B. Wang, Sun, Song, & Gao, 2015).

**Treatment of hypocalcemia**

Although several authors have identified some predictive factors for postoperative hypocalcemia, it is still difficult to predict which patients would need of calcium and vitamin D supplementation in the postoperative period to treat or prevent signs and symptoms of low plasma calcium (Barbier et al., 2022; Bove et al., 2020; Cannizzaro, Okatyeva, Bianco, Caruso, & Buffone, 2018; de Carvalho et al., 2021; McMurran et al., 2020; Pãduraru et al., 2019).

Patients with symptomatic hypocalcemia and low blood calcium levels receive oral calcium supplementation (1 to 4 grams/day) with or without vitamin D (Kellerman & Rakel, 2020). Some patients with severe hypocalcemia and/or important manifestations also receive, at the beginning, venous calcium gluconate, administered slowly, until these manifestations improve (Barbier et al., 2022). Cases of hypomagnesemia should receive magnesium supplementation in the form of magnesium sulfate by mouth. intravenous (Barbier et al., 2022).

PTH is commercially available, but its use requires daily intramuscular applications, in addition to being very expensive (Barbier et al., 2022). Calcium carbonate is absorbed in the duodenum, and 20.0% to 30.0% of this absorption is dependent on vitamin D, which is prescribed in the most active form (vitamin D - calcitriol), at a dose of 0.25 mg to 0.50 mg per day (Saha & Goswami, 2019). A low-phosphate diet is also recommended (Barbier et al., 2022). Some researchers informed their patients about the clinical manifestations of postoperative hypocalcemia and give them calcium carbonate so that they can, if necessary, that is, in the presence of symptoms, start medication (Yamaguchi et al., 2020). In this case, routine laboratory tests are not performed(Donahue et al., 2021).

On the other hand, others empirically treat patients submitted to total thyroidectomy or bilateral TS and, without requesting tests in the postoperative period, release them home early (Donahue et al., 2021; Radakrishnan et al., 2021). The efficacy and safety of these alternative treatments still need further studies, since those currently available are not fully accepted by the scientific community. For Khatiwada & Harris, (2021) and Bhettani et al., (2019), routine oral calcium supplementation in the postoperative period, in addition to being empirical, has an ineffective cost-benefit ratio, and therefore its indication is not justified (Bhettani et al., 2019; Khatiwada & Harris, 2021).

Pãduraru et al., (2019) found that the administration of calcium in the immediate postoperative period, with or without vitamin D, effectively reduced the signs and symptoms of postoperative hypocalcemia (Pãduraru et al., 2019). Patients were discharged early and safely, and many of them had oral calcium administration suspended a few days after the operation, upon laboratory confirmation of normal serum calcium (Kazaure et al., 2021). This treatment reduced the risk of symptoms without inhibiting PTH secretion by normofunctioning parathyroids (Bashir et al., 2021).

Donahue et al., (2021), Sanabria et al., (2019) and Tartaglia et al., (2005) showed that the combined administration of calcium and calcitriol after total thyroidectomy reduces the risk of severe hypocalcemia, warning, however, that

10.0% to 13.0% of patients may still have calcium levels below 7 and 5 mg/dl on the second and third postoperative days and, respectively, clinical manifestations (Donahue et al., 2021; A Sanabria, Rojas, & Arevalo, 2019; Tartaglia et al., 2005).

**Changing the other ions**
**Phosphorus**

The adult human organism contains about 600 g of phosphorus (1.0% of body weight), of which 85.0% is in the skeleton, while the rest (15.0%) is found in the extracellular fluid, in the form of inorganic phosphate, and in soft tissues, in the form of phosphate esters (Lanham-New, Hill, Gallagher, & Vorster, 2019). The intestinal and renal absorption and excretion of phosphorus are related to the concentration of PTH. PTH increases the concentration of vitamin D, which, in turn, is responsible for stimulating the active absorption of this ion in the intestine. In the kidneys, PTH acts directly on the proximal tubules, decreasing phosphorus reabsorption and increasing phosphaturia (Bilezikian, Martin, Clemens, & Rosen, 2019; Lanham-New et al., 2019; Pham-Huy & Huy, 2022).

Serum phosphorus concentration drops more rapidly in response to PTH than increases in calcium. Thus, monitoring phosphorus in hypocalcemic patients in need of calcium supplementation may indicate, earlier, the return of parathyroid gland function (Bilezikian et al., 2019; Lanham-New et al., 2019; Pham-Huy & Huy, 2022). According to the available literature data, when serum calcium remains less than or equal to 8.0 mg/dl (8.4 mg/dl to 10.2 mg/dl) or phosphorus levels are greater than or equal to 4.0 mg/dl (2.5 mg/dl to 4.5 mg/dl), the risk of permanent hypoparathyroidism is on the order of 66.0% and 69.0%, respectively (Bilezikian et al., 2019; Lanham-New et al., 2019; Pham-Huy & Huy, 2022).

**Magnesium**

Some in vitro and in vivo studies have shown that magnesium can regulate PTH secretion in a similar way to calcium. The enzyme adenylate cyclase requires magnesium to generate cyclic adenosine monophosphate (cAMP), which, in turn, is a peripheral mediator of parathyroid cells, regulating PTH secretion. Magnesium deficiency increases the sensitivity of parathyroid cells to calcium, by reducing the activation of adenylate cyclase and, consequently, the release of PTH (Freitag et al., 1979; MAHAFFEE, COOPER, RAMP, & ONTJES, 1982; Nguyen, Tran, Nguyen, & Nguyen, 2021; Palermo et al., 2019; RUDE, OLDHAM, SHARP Jr, & SINGER, 1978; J. Xu et al., 2022).

Magnesium deficiency also reduces the effect of PTH on the kidneys and bones and increases its degradation in the liver and kidneys. Consequently, all hypocalcemic patients with magnesium deficiency will have relative hypoparathyroidism (Pepe et al., 2020) . Magnesium also participates in the metabolism and action of vitamin D (Tecilazich et al., 2018). Patients with hypocalcemia and hypomagnesemia are resistant to large doses of vitamin D, caused by the reduction in both PTH and renal resistance to this hormone (Jain et al., 2021).

In addition, oral administration of vitamin D does not increase calcium levels. Hypomagnesemia associated with hypocalcemia makes patients more symptomatic, and plasma calcium correction without concomitant normalization of magnesium may maintain manifestations for longer (A. A. Khan et al., 2019). Temporary hypoparathyroidism leads to reduced renal tubular reabsorption of magnesium, and extracellular volume expansion increases the its excretion (Chincholikar & Ambiger, 2018). According to deep studies conducted by Wilson and others, approximately 10.0% of patients undergoing total thyroidectomy develop hypomagnesemia and hypocalcemia (Stojanovska et al., 2021; G. Wilson, Nistor, & Beasley, 2022; R. B. Wilson, Erskine, & Crowe, 2000).

**Hyperparathyroidism**

PTH measurement by immuno-chemiluminescence assay was described by Irvin III et al., (1999) (Irvin III, Molinari, Figueroa, & Carneiro, 1999), and has recently been considered a standard test by several authors (Bhangu & Riss, 2019; Carneiro-Pla & Pellitteri, 2021; Z. F. Khan & Lew, 2019; Leung et al., 2019). PTH measurements are performed at different times of the postoperative period - 10 minutes, one, two, four or eight hours - and its result is released in 15 minutes (Covic, Goldsmith, & Torres, 2020).

Due to the difficulty in predicting which patients will develop postoperative hypocalcemia, some authors, based on the operation and in serum calcium values, have shown a correlation between hypocalcemia and the drop in PTH in the immediate postoperative period, with statistically significant results (Covic et al., 2020; Kritmetapak & Pongchaiyakul, 2019; K Lorenz, Schneider, & Elwerr, 2020; Mak et al., 2020; S. D. Tsai et al., 2019).

PTH values below 7.0 pg/ml have high sensitivity and specificity in predicting postoperative hypocalcemia56. The recent published studies opt for pre- and postoperative PTH dosages, instead of considering its postoperative value in isolation (K Lorenz et al., 2020; Palmhag et al., 2021). According to Sakr, (2020), a PTH concentration lower than 10.0 pg/ml indicates symptomatic hypocalcemia in the postoperative period ($p < 0.0001$) (Mahmoud F Sakr, 2020). With this value, the sensitivity verified in the study developed by these authors was 80.0%; the specificity of 100.0%; the positive predictive value of 100.0%; and the negative predictive value of 91.0% (Mahmoud F Sakr, 2020).

Bhettani et al., (2019), Kim et al., (2015), Nagel et al., (2022), Pertsemlidis et al., (2017) and Shifrin, (2021) suggested calcium and vitamin D replacement for patients with a drop of 70.0% or more in PTH compared to the preoperative period (Bhettani et al., 2019; W. W. Kim et al., 2015; Nagel et al., 2022; Pertsemlidis, Inabnet, & Gagner, 2017; A. L. Shifrin, 2021). They also observed that intraoperative PTH values (after thyroid resection) below 10.0 pg/ml may indicate damage to the parathyroids and, consequently, the need to resect and reimplant them to prevent definitive hypoparathyroidism (Bhettani et al., 2019; W. W. Kim et al., 2015; Nagel et al., 2022; Pertsemlidis et al., 2017; A. L. Shifrin, 2021). They showed that the sensitivity and specificity of intraoperative PTH measurement in predicting biochemical and symptomatic hypocalcemia were not significantly different from calcium measurement on the day after the operation.

Some authors also report that postoperative PTH levels within the normal range are associated with a very low risk of hypocalcemia (Bhettani et al., 2019; W. W. Kim et al., 2015; Nagel et al., 2022; Pertsemlidis et al., 2017; A. L. Shifrin, 2021). Sormaz et al., (2021) reported that patients with normal calcium values and PTH values above 28.0 pg/ml six hours after the operation had a very low risk of developing hypocalcemia (Sormaz et al., 2021).

According to Kim et al., (2021) and others, performing two PTH measurements (intraoperative and immediate postoperative), found that PTH values greater than 10.0 pg/ml and an increase in postoperative PTH compared to intraoperatively indicate low risk of hypocalcemia (Daskalaki et al., 2022; D. H. Kim et al., 2021; Rahman, 2021). Treating all patients with PTH < 8.0 pg/ml, measured one hour after the operation, reduced the incidence of postoperative hypocalcemia by 50.0%.

## Conclusions

The incidence of early postoperative hypocalcemia and at 6-month follow-up is normally revealed with factors involved with hypocalcemia. The patients need calcium replacement in the postoperative period and, of these, are evolved to definitive hypoparathyroidism. There is importance of changes in magnesium and phosphorus ions in patients with postoperative hypocalcemia, with or without clinical manifestations, correlating them with changes in calcium. Hypocalcemia is a common complication after thyroidectomy surgery. Symptoms can be varied, from mild (spasms, paresthesias) to severe life-threatening symptoms (tetany, laryngospasm, convulsions, arrhythmias and cardiac arrest). Calcium replacement should be guided by symptoms and serum calcium levels. Mild cases should be treated with calcium replacement (calcium carbonate, calcium citrate) and calcitriol, both by mouth. Severe and refractory cases should be treated with the previous option + intravenous calcium replacement (formulations with gluconate and calcium chloride are the most common). Other variables that are associated with a higher incidence of hypocalcemia include types of operation, operative time, underlying disease, neck dissection and vocal fold paralysis.

## References

Abdel-Aziz, E. Z., Elfeky, H. A. A., & AboSeda, A. (2018). Electrolytes imbalance among patients with oncologic emergencies at a university hospital. *International Academic Journal of Health, Medicine and Nursing, 1*(2), 58-83.

Abdelaziz, M., Essawy, A., Wageh, H., Khalifa, N., & Zydan, M. (2021). Parathyroid Hormone as a Predictor of Post Total Thyroidectomy Parathyroid Gland Injury. *International Journal of Cancer and Biomedical Research, 5*(3), 133-139.

Abdelhamid, A. F., & Moussa, H. R. (2020). Risk factors of hypocalcemia after thyroid surgery. *The Egyptian Journal of Surgery, 39*(4), 1163-1169.

Acton, Q. A. (2012). *Hypocalcemia: New Insights for the Healthcare Professional: 2011 Edition: ScholarlyPaper*: ScholarlyEditions.

Ahmed, S. Z., Waseem, T., Zafar, Z., & Abid, M. (2020). Impact of Branch vs. Truncal Ligation of Inferior Thyroid Arteries on Post-Thyroidectomy

Hypocalcaemia:: A Meta-Analysis of Controlled Trials. *Archives of Surgical Research, 1*(2), 6-15.

Ahn, S. V., Lee, J.-H., Bove-Fenderson, E. A., Park, S. Y., Mannstadt, M., & Lee, S. (2019). Incidence of hypoparathyroidism after thyroid cancer surgery in South Korea, 2007-2016. *Jama, 322*(24), 2441-2442.

Akdeniz, D. D., & Avcı, G. (2021). Total or less than total thyroidectomy for multinodular goiter long term follow-up. *Medical Science and Discovery, 8*(3), 181-186.

Al Ibrahimi, S. M., & Ahmed, I. N. (2021). AACE2021-A-1067: Albright's Hereditary Osteodystrophy: A Rare but Important Cause of Hypocalcemia. *Endocrine Practice, 27*(12), S27-S28.

Al Kordy, M. A. R., El Ewesy, E. A., & Hassan, A. J. N. (2019). Effect of Ligation of Inferior Thyroid Artery Main Trunk vs. its Branches on Post Thyroidectomy Hypocalcaemia. *The Egyptian Journal of Hospital Medicine, 76*(2), 3419-3424.

Al Najjar, M., Ghoush, M. S. A., Elmajed, N., Eldimllawi, A., & Abousalha, A. (2021). Severe Refractory Hypocalcemia after Parathyroidectomy for Hyperparathyroidism and Parathyroid Adenoma in a Patient with Prior Bariatric Surgery: A Rare Case Report. *American Journal of Medical Case Reports, 9*(11), 664-666.

Albert Stepansky, M., Natan Poluksht, M., Philippe Hagag, M., & Ilan Wassermann, M. (2010). intraoperative Parathormone measurements and Postoperative Hypocalcemia.

Ale, A. F., Isichei, M. W., & Misauno, M. A. (2020). The outcome of short stay thyroidectomy in rural medical outreach settings in Northern Nigeria. *International Journal of Research in Medical Sciences, 8*(3), 1007.

Alghamdi, M. A. (2019). Thyroidectomy Indications and Complications. *EC Microbiology, 15*, 609-615.

Al-Hussain, O. H., Kurdi, A. K., Alnoqaidan, E. A., Badr, G. H., Alshahrani, F. A., Alqahtani, S. A., . . . Al-Ajlani, A. A. A. (2020). An Overview of Thyroidectomy Complications Management: Literature Review. *Journal of Biochemical Technology, 11*(4).

Allgrove, J., & Shaw, N. J. (2015). *Calcium and Bone Disorders in Children and Adolescents*: S. Karger AG.

Alqahtani, S. M., Almussallam, B., Alatawi, A. S., Alsuhaimi, N. A., Albalawi, A., Albalawi, N. S., . . . Alalawi, Y. (2020). Post-thyroidectomy complications and risk factors in Tabuk, Saudi Arabia: a retrospective cohort study. *Cureus, 12*(10).

Alveryd, A. (1968). Parathyroid glands in thyroid surgery. I. Anatomy of parathyroid glands. II. Postoperative hypoparathyroidism--identification and autotransplantation of parathyroid glands. *Acta Chirurgica Scandinavica, 389*, 1-120.

Azaria, S. (2019). *Quality of life Post Thyroidectomy in Benign Goitres.* Christian Medical College, Vellore.

Babu, T. S. (2021). A study of post-operative hypocalcemia in thyroidectomy patients: Prospective observational study. *INTERNATIONAL JOURNAL OF SCIENTIFIC STUDY, 8*(10), 92-95.

Băetu, M., Olariu, C. A., Nițu, I., Moldoveanu, G., Corneci, C., & Badiu, C. (2021). Safety of calcitonin stimulation tests with calcium. *Hormones, 20*(4), 769-775.

Băetu, M., Olariu, C. A., Stancu, C., Caragheorgheopol, A., Ioachim, D., Moldoveanu, G., . . . Badiu, C. (2021). Thresholds of Basal-and Calcium-

Stimulated Calcitonin for Diagnosis of Thyroid Malignancy. *Hormone and Metabolic Research, 53*(12), 779-786.

Bai, B., Chen, Z., & Chen, W. (2018). Risk factors and outcomes of incidental parathyroidectomy in thyroidectomy: A systematic review and meta-analysis. *PloS one, 13*(11), e0207088.

Baldassarre, R. L. (2014). *Predictors of Hypocalcemia After Thyroidectomy: Results from the Nationwide Inpatient Sample*: University of California, San Diego.

Barbier, M. P., Mingote, E., Sforza, N., Morosán Allo, Y., Lotartaro, M., Serrano, L., . . . Sedlinsky, C. (2022). Incidence and predictive factors of postoperative hypocalcaemia according to type of thyroid surgery in older adults. *Endocrine, 75*(1), 276-283.

Barczyński, M., Gołkowski, F., & Nawrot, I. (2017). Parathyroid transplantation in thyroid surgery. *Gland Surgery, 6*(5), 530.

Bashir, A. Y., Alzubaidi, A. N., Bashir, M. A., Obed, A. H., Zakarneh, R. K., Ennab, H. Z., . . . Bashir, A. A. (2021). The optimal parathyroid hormone cut-off threshold for early and safe management of hypocalcemia after total thyroidectomy. *Endocrine Practice, 27*(9), 925-933.

Bateman, K., & Egan, R. (2022). Hypercalcaemia and hyperparathyroidism in surgical practice (Vol. 109, pp. 481-482): Oxford University Press.

Bawa, D., Alghamdi, A., Albishi, H., Al-Tufail, N., Sharma, S. P., Khalifa, Y. M., . . . Alhajmohammed, M. A. (2021). Post-thyroidectomy complications in southwestern Saudi Arabia: a retrospective study of a 6-year period. *Annals of Saudi medicine, 41*(6), 369-375.

Bergamaschi, R., Becouarn, G., Ronceray, J., & Arnaud, J.-P. (1998). Morbidity of thyroid surgery. *The American Journal of Surgery, 176*(1), 71-75.

Bhangu, J. S., & Riss, P. (2019). The role of intraoperative parathyroid hormone (IOPTH) determination for identification and surgical strategy of sporadic multiglandular disease in primary hyperparathyroidism (pHPT). *Best Practice & Research Clinical Endocrinology & Metabolism, 33*(5), 101310.

Bhettani, M. K., Rehman, M., Ahmed, M., Altaf, H. N., Choudry, U. K., & Khan, K. H. (2019). Role of pre-operative vitamin D supplementation to reduce post-thyroidectomy hypocalcemia; Cohort study. *International Journal of Surgery, 71*, 85-90.

Bilezikian, J. P., Marcus, R., & Levine, M. A. (2001). *The Parathyroids: Basic and Clinical Concepts*: Elsevier Science.

Bilezikian, J. P., Martin, T. J., Clemens, T. L., & Rosen, C. J. (2019). *Principles of Bone Biology*: Elsevier Science.

Bjornsdottir, S., Ing, S., Mitchell, D. M., Sikjaer, T., Underbjerg, L., Hassan-Smith, Z., . . . Clarke, B. (2022). Epidemiology and financial burden of adult chronic hypoparathyroidism. *Journal of Bone and Mineral Research*.

Bobanga, I. D., & McHenry, C. R. (2021). Surgical Procedures. Thyroidectomy: Indications, Flexible Laryngoscopy, Operative Techniques, Recurrent Laryngeal Nerve Monitoring, and Management of Complications *Endocrine Surgery Comprehensive Board Exam Guide* (pp. 217-245): Springer.

Boutzios, G., Tsourouflis, G., Garoufalia, Z., Alexandraki, K., & Kouraklis, G. (2019). Long-term sequelae of the less than total thyroidectomy procedures for benign thyroid nodular disease. *Endocrine, 63*(2), 247-251.

Bove, A., Dei Rocini, C., Di Renzo, R., Farrukh, M., Palone, G., Chiarini, S., & Staniscia, T. (2020). Vitamin D deficiency as a predictive factor of transient hypocalcemia after total thyroidectomy. *International Journal of Endocrinology, 2020*.

Brophy, C., Woods, R., Murphy, M. S., & Sheahan, P. (2019). Perioperative magnesium levels in total thyroidectomy and relationship to hypocalcemia. *Head & Neck, 41*(6), 1713-1718.

Brunner, L. S., Smeltzer, S. C. O. C., Bare, B. G., Hinkle, J. L., & Cheever, K. H. (2010). *Brunner & Suddarth's Textbook of Medical-surgical Nursing*: Wolters Kluwer Health/Lippincott Williams & Wilkins.

Bruno, B., Amaral, S., Vasques, M., Monteiro, N., Crespo, A., José, C., . . . José, S.-N. (2021). *Transient hypocalcaemia and definitive hypoparathyroidism after total thyroidectomy in Graves' disease*. Paper presented at the Endocrine Abstracts.

Bugălă, N. M., Carsote, M., Stoica, L. E., Albulescu, D. M., Țuculină, M. J., Preda, S. A., . . . Alexandru, D. O. (2022). New Approach to Addison Disease: Oral Manifestations Due to Endocrine Dysfunction and Comorbidity Burden. *Diagnostics, 12*(9), 2080.

Bumber, B., Potroško, V., Vugrinec, O., Ferenčaković, M., & Gršić, K. (2020). Hypocalcemia After Completion Thyroidectomy for Papillary Thyroid Carcinoma. *Acta Clinica Croatica, 59*(Supplement 1), 136-144.

Busch, B., Bradley, J., & Guardiola, J. (2022). Trousseau sign of latent tetany in a patient with Crohn's Disease. *The American Journal of the Medical Sciences*.

Butt, M. B., Fayyaz, S., Quratulain, V. B., & Sultan, W. (2022). Frequency of Hypocalcemia after Thyroid Surgery. *Pakistan Journal of Medical & Health Sciences, 16*(04), 1219-1219.

Cali, B., Hasani, A., Buffet, C., Menegaux, F., & Chereau, N. (2021). Is there a relationship between different types of prior bariatric surgery and post-thyroidectomy hypocalcemia? *Gland Surgery, 10*(7), 2088.

Cannizzaro, M. A., Okatyeva, V., Bianco, S. L., Caruso, V., & Buffone, A. (2018). Hypocalcemia after thyroidectomy: iPTH levels and iPTH decline are predictive? Retrospective cohort study. *Annals of Medicine and Surgery, 30*, 42-45.

Carneiro-Pla, D., & Pellitteri, P. K. (2021). Intraoperative PTH monitoring during parathyroid surgery *Surgery of the Thyroid and Parathyroid Glands* (pp. 546-552. e542): Elsevier.

Ceylan, M. E., & Kesici, M. E. (2022). The effect of intraoperative nerve monitor use on recurrent laryngeal nerve injury and hypocalcemia in benign thyroid diseases after total thyroidectomy or loboisthmectomy: Thirteen years single surgeon experience.

Chang, J. W., Park, K. W., Jung, S.-N., Liu, L., Kim, S. M., & Koo, B. S. (2020). The most reliable time point for intact parathyroid hormone measurement to predict hypoparathyroidism after total thyroidectomy with central neck dissection to treat papillary thyroid carcinoma: a prospective cohort study. *European Archives of Oto-Rhino-Laryngology, 277*(2), 549-558.

Chen, C.-F., Lee, C.-Y., Chen, F.-A., Yang, C.-Y., Chen, T.-H., Ou, S.-M., . . . Lee, P.-C. (2022). Far-Infrared Therapy Improves Arteriovenous Fistula Patency and Decreases Plasma Asymmetric Dimethylarginine in Patients with Advanced Diabetic Kidney Disease: A Prospective Randomized Controlled Trial. *Journal of clinical medicine, 11*(14), 4168.

Chen, Z., Zhao, Q., Du, J., Wang, Y., Han, R., Xu, C., . . . Shu, M. (2021). Risk factors for postoperative hypocalcaemia after thyroidectomy: A systematic review and meta-analysis. *Journal of International Medical Research, 49*(3), 0300060521996911.

Chin, C. M., Gutierrez, M., Still, J. G., & Kosutic, G. (2004). Pharmacokinetics of modified oral calcitonin product in healthy volunteers. *Pharmacotherapy: The Journal of Human Pharmacology and Drug Therapy, 24*(8), 994-1001.

Chincholikar, S. P., & Ambiger, S. (2018). Association of hypomagnesemia with hypocalcemia after thyroidectomy. *Indian Journal of Endocrinology and Metabolism, 22*(5), 656.

Cornelius, B. (2020). Incidence of Hypocalcemia and Role of Calcium Replacement in Major Trauma Patients Requiring Operative Intervention. *AANA journal, 88*(5).

Covic, A., Goldsmith, D., & Torres, P. A. U. (2020). *Parathyroid Glands in Chronic Kidney Disease*: Springer International Publishing.

Daba, K. T., Weldemichael, D. K., & Mulugeta, G. A. (2019). Bilateral hypocalcemic cataract after total thyroidectomy in a young woman: case report. *BMC ophthalmology, 19*(1), 1-3.

Daskalaki, A., Xenaki, S., Lasithiotakis, K., Chrysos, A., Kampa, M., Notas, G., & Chrysos, E. (2022). Early Postoperative Parathormone and Calcium as Prognostic Factors for Postoperative Hypocalcemia. *Journal of clinical medicine, 11*(9), 2389.

de Carvalho, G. B., Diamantino, L. R., Schiaveto, L. F., Forster, C. H. Q., Shiguemori, É. H., Hirata, D., . . . Matieli, J. E. (2021). Identification of secondary predictive factors for acute hypocalcemia following thyroidectomy in patients with low postoperative parathyroid hormone levels without overt calcium deficiency: A cohort study. *American journal of otolaryngology, 42*(6), 103115.

Del Rio, A., Rico, H., Bordiu, E., & Novoa, D. (1987). Calcitonin-induced hypocalcaemia as a possible index of osteoclastic activity in patients with chronic renal failure. *Nephron, 47*(4), 241-245.

Del Rio, P., Rossini, M., Montana, C. M., Viani, L., Pedrazzi, G., Loderer, T., & Cozzani, F. (2019). Postoperative hypocalcemia: analysis of factors influencing early hypocalcemia development following thyroid surgery. *BMC surgery, 18*(1), 1-8.

Delitala, A. P., Scuteri, A., & Doria, C. (2020). Thyroid hormone diseases and osteoporosis. *Journal of clinical medicine, 9*(4), 1034.

Dennis, M., Bowen, W. T., & Cho, L. (2012). *Mechanisms of Clinical Signs*: Churchill Livingstone.

Dhahri, A. A., Ahmad, R., Rao, A., Bhatti, D., Ahmad, S. H., Ghufran, S., & Kirmani, N. (2021). Use of Prophylactic Steroids to Prevent Hypocalcemia and Voice Dysfunction in Patients Undergoing Thyroidectomy: A Randomized Clinical Trial. *JAMA Otolaryngology–Head & Neck Surgery, 147*(10), 866-870.

di Filippo, L., Doga, M., Frara, S., & Giustina, A. (2021). Hypocalcemia in COVID-19: Prevalence, clinical significance and therapeutic implications. *Reviews in Endocrine and Metabolic Disorders*, 1-10.

Díez, J. J., Anda, E., Sastre, J., Corral, B. P., Álvarez-Escolá, C., Manjón, L., . . . Carrera, C. B. (2020). Permanent postoperative hypoparathyroidism: an analysis of prevalence and predictive factors for adequacy of control in a cohort of 260 patients. *Gland Surgery, 9*(5), 1380.

Díez, J. J., Anda, E., Sastre, J., Perez Corral, B., Álvarez-Escolá, C., Manjón, L., . . . Blanco Carrera, C. (2019). Prevalence and risk factors for hypoparathyroidism following total thyroidectomy in Spain: a multicentric and nation-wide retrospective analysis. *Endocrine, 66*(2), 405-415.

Díez, J. J., Anda, E., Sastre, J., Pérez-Corral, B., Álvarez-Escolá, C., Manjón, L., . . . Blanco-Carrera, C. (2021). Recovery of parathyroid function in patients with thyroid cancer treated by total thyroidectomy: An analysis of 685 patients with hypoparathyroidism at discharge of surgery. *Endocrinología, Diabetes y Nutrición (English ed.), 68*(6), 398-407.

Dobrinja, C., Samardzic, N., Giudici, F., Raffaelli, M., De Crea, C., Sessa, L., . . . Varaldo, E. (2021). Hemithyroidectomy versus total thyroidectomy in the intermediate-risk differentiated thyroid cancer: The Italian Societies of Endocrine Surgeons and Surgical Oncology Multicentric Study. *Updates in Surgery, 73*(5), 1909-1921.

Donahue, C., Pantel, H. J., Yarlagadda, B. B., & Brams, D. (2021). Does preoperative calcium and calcitriol decrease rates of post-thyroidectomy hypocalcemia? A randomized clinical trial. *Journal of the American College of Surgeons, 232*(6), 848-854.

Edafe, O., Mech, C. E., & Balasubramanian, S. P. (2019). Calcium, vitamin D or recombinant parathyroid hormone for managing post-thyroidectomy hypoparathyroidism. *Cochrane Database of Systematic Reviews*(5).

Eltyeb, M. E. I. (2021). *Assesment of Bone Density by Using CT in Paitent With Thyroid Disorder in Algazira state.* Sudan University of Science and Technology.

Essa, M. S., Ahmad, K. S., Fadey, M. A., El-Shaer, M. O., Salama, A. M., & Zayed, M. E. (2021). Role of perioperative parathormone hormone level assay after total thyroidectomy as a predictor of transient and permanent hypocalcemia: Prospective study. *Annals of Medicine and Surgery, 69*, 102701.

Falch, C., Hornig, J., Senne, M., Braun, M., Konigsrainer, A., Kirschniak, A., & Muller, S. (2018). Factors predicting hypocalcemia after total thyroidectomy–A retrospective cohort analysis. *International Journal of Surgery, 55*, 46-50.

Figueiredo, S. G., & Joliat, G.-R. (2020). Main d'accoucheur (obstetrician's hand) after thyroidectomy: a video-illustrated case report.

Freeman, J. L., Sewell, A. B., Hales, N. W., & Randolph, G. W. (2021). Reoperative thyroid surgery *Surgery of the thyroid and parathyroid glands* (pp. 461-471. e463): Elsevier.

Freitag, J. J., Martin, K. J., Conrades, M. B., Bellorin-Font, E., Teitelbaum, S., Klahr, S., & Slatopolsky, E. (1979). Evidence for skeletal resistance to parathyroid hormone in magnesium deficiency: Studies in isolated perfused bone. *The Journal of clinical investigation, 64*(5), 1238-1244.

Freitas, C. A. F. d., Levenhagen, M. M. M. D., Constantino, I. S., Paroni, A. F., & Martins, M. R. (2020). Relation of Nonrecurrent Laryngeal Nerve with Zuckerkandl's Tubercle. *Case Reports in Surgery, 2020*.

Gado, W. (2019). Total Thyroidectomy as Primary Surgical Management for Nonmalignant Thyroid Disorders. *J Surg, 4*, 1267.

Galesanu, C., Niculescu, D., Apostu, L., & Romeo, G. M. (2018). *When it is the time of prophylactic thyroidectomy to children with medullary thyroid cancer with RET proto-oncogene Cys634Trp mutation in a family with multiple endocrine neoplasia type 2A.* Paper presented at the Endocrine Abstracts.

Gao, Z., Li, X., Miao, J., & Lun, L. (2019). Impacts of parathyroidectomy on calcium and phosphorus metabolism disorder, arterial calcification and arterial stiffness in haemodialysis patients. *Asian journal of surgery, 42*(1), 6-10.

Gardella, T. J., Nissenson, R. A., & Jüppner, H. (2018). Parathyroid Hormone. *Primer on the Metabolic Bone Diseases and Disorders of Mineral Metabolism; Wiley Online Library: Hoboken, NJ, USA*, 205-211.
Gemsenjaeger, E. (2011). *Atlas of Thyroid Surgery: Principles, Practice, and Clinical Cases - Book and DVD*: Thieme.
Ghafoor, M. T., Haider, S. S., Kousar, N., Sabir, S., Tariq, M., & Bashir, M. (2020). EFFECT OF IN SITU PRESERVATION OF PARATHYROID GLAND ON CALCIUM LEVEL AFTER TOTAL THYROIDECTOMY. *Pak J Pathol, 31*(3), 69-73.
Giannetta, E., Guarnotta, V., Altieri, B., Sciammarella, C., Guadagno, E., Malandrino, P., . . . Colao, A. A. L. (2020). ENDOCRINE TUMOURS: Calcitonin in thyroid and extra-thyroid neuroendocrine neoplasms: the two-faced Janus. *European Journal of Endocrinology, 183*(6), R197-R215.
Giddings, A. (1998). The history of thyroidectomy. *Journal of the royal society of medicine, 91*(33_suppl), 3-6.
Godlewska, P., Benke, M., Stachlewska-Nasfeter, E., Gałczyński, J., Puła, B., & Dedecjus, M. (2020). Risk factors of permanent hypoparathyroidism after total thyroidectomy and central neck dissection for papillary thyroid cancer: a prospective study. *Endokrynologia Polska, 71*(2), 126-133.
Grodski, S., & Serpell, J. (2008). Evidence for the role of perioperative PTH measurement after total thyroidectomy as a predictor of hypocalcemia. *World journal of surgery, 32*(7), 1367-1373.
Gunn, A., Oyekunle, T., Stang, M., Kazaure, H., & Scheri, R. (2020). Recurrent laryngeal nerve injury after thyroid surgery: an analysis of 11,370 patients. *Journal of Surgical Research, 255*, 42-49.
Guo, Z., Zhao, L., Xie, Y., Yan, Y., & Mo, Z. (2021). Hungry Bone Syndrome Secondary to Subtotal Thyroidectomy in A Patient With Thyrotoxicosis. *The American Journal of the Medical Sciences, 362*(3), 314-320.
Hamdan, A. L., Sataloff, R. T., & Hawkshaw, M. J. (2020). *Non-Laryngeal Cancer and Voice*: Plural Publishing, Incorporated.
Hamed, M. K., & Afifi, A. H. (2019). Role of Intact Parathyroid Hormone (iPTH) Level as an Early Predictor of Postoperative Hypocalcemia after Total Thyroidectomy for Simple Multi-Nodular Goiter. *Ain Shams Journal of Surgery, 21*(2), 144-159.
Hamid, T., Usman, A., Khan, S. U., Nasr, A. R., Usman, J., Ali, M., & Maliki, J. R. (2022). Early Hypocalcemia after Sub-Total, Near-Total and Total Thyroidectomy: its Diagnosis and Treatment Options. *Pakistan Journal of Medical & Health Sciences, 16*(05), 677-677.
Hanks, J. B., & Inabnet, W. B. (2015). *Controversies in Thyroid Surgery*: Springer International Publishing.
Hemmati, H., Motamed, B., Pursafar, M., Farzin, M., Jafaryparvar, Z., Delshad, M. S. E., . . . Bahush, S. (2021). The Relationship Between the Serum Level of Vitamin D and Hypocalcemia After Total Thyroidectomy. *Acta Medica Iranica, 59*(12), 699.
Hsiao, C.-Y., Chen, T.-H., Chu, T.-H., Ting, Y.-N., Tsai, P.-J., & Shyu, J.-F. (2020). Calcitonin induces bone formation by increasing expression of Wnt10b in osteoclasts in ovariectomy-induced osteoporotic rats. *Frontiers in Endocrinology, 11*, 613.
Hurjui, L. L., Hurjui, I., Delianu, C., Tărniceriu, C. C., Mârțu, A. M., Balcoș, C., . . . Hârțan, R. M. (2020). Biological markers importance in the diagnosis of osteoporosis. *Romanian Journal of Oral Rehabilitation, 12*(4), 181-189.

Ibrahim, Y. L. U. F. D., & Anumahb, A. F. E. (2021). Recurrent Hypocalcemic Tetany as the Initial Presentation in Some Persons with Hyperthyroidism: A Case Series.

Ignjatović, M. (2010). The thyroid gland in works of famous old anatomists and great artists. *Langenbeck's archives of surgery, 395*(7), 973-985.

Iorio, O., Petrozza, V., De Gori, A., Bononi, M., Porta, N., De Toma, G., & Cavallaro, G. (2018). Parathyroid Autotransplantation During thyroid Surgery. Where we are? A Systematic review on indications and results. *Journal of Investigative Surgery*.

Irvin III, G. L., Molinari, A. S., Figueroa, C., & Carneiro, D. M. (1999). Improved success rate in reoperative parathyroidectomy with intraoperative PTH assay. *Annals of surgery, 229*(6), 874.

Ismailov, S. I., & Khayitboyeva, K. K. (2019). Problems of diagnostics and treatment of diffuse—toxic goiter (Graves' disease).

Jacoby, N. (2020). Electrolyte disorders and the nervous system. *CONTINUUM: Lifelong Learning in Neurology, 26*(3), 632-658.

Jagadeesan, N. (2020). *Clinical Profile of Solitary Nodule Goitre.* Thanjavur Medical College, Thanjavur.

Jain, G., Das, G., Malhotra, R., Ramchandran, S., Phani, N. M., Appaswamy, G., . . . Dwivedi, A. (2021). Hypomagnesemia with Secondary Hypoparathyroidism and Hypocalcemia due to Novel Variants in the Transient Receptor Potential Cation Channel Subfamily M Member 6 (TRPM6) Gene. *Journal of Pediatric Genetics*.

Jin, S., & Sugitani, I. (2021). Narrative review of management of thyroid surgery complications. *Gland Surgery, 10*(3), 1135.

JM, R. G., & NM, T. P. (2004). Hypoparathyroidism and hypocalcemia following thyroid surgery of multinodular goiter. Multivariant study of the risk factors. *Medicina Clinica, 122*(10), 365-368.

Jongekkasit, I., Jitpratoom, P., Sasanakietkul, T., & Anuwong, A. (2019). Transoral endoscopic thyroidectomy for thyroid cancer. *Endocrinology and Metabolism Clinics, 48*(1), 165-180.

Jukic, A. (2017). *Incidence of Difficult Intubation in Patients Undergoing Thyroid Gland Reoperation Due to Bleeding Or Haematoma*.

Jung, J. H., Kim, T. H., Ji, Y. B., Jeong, J. H., Lee, S. H., Park, C. W., & Tae, K. (2013). Hypoparathyroidism after thyroidectomy and the effect of parathyroid autotransplantation. *Korean J Otorhinolaryngol-Head Neck Surg, 56*(1), 28-33.

Kandinov, A., Nguyen, B. K., Yuhan, B. T., Johnson, A. P., & Svider, P. F. (2021). Evidence-based perioperative analgesia for otolaryngology: head and neck surgery *Perioperative pain control: tools for surgeons* (pp. 175-206): Springer.

Kaptanoglu, M. (2022). Thyroid Surgery: Thyroidectomy. *J Uni Sur, 10*(7), 58.

Kazaure, H. S., Zambeli-Ljepovic, A., Oyekunle, T., Roman, S. A., Sosa, J. A., Stang, M. T., & Scheri, R. P. (2021). Severe hypocalcemia after thyroidectomy: an analysis of 7366 patients. *Annals of surgery, 274*(6), e1014-e1021.

Kellerman, R. D., & Rakel, D. (2020). *Conn's Current Therapy 2021*: Elsevier Health Sciences.

Kh, K. K. (2019). Problems of diagnostics and treatment of diffuse-toxic goiter (Graves' disease). *Вестник Санкт-Петербургского университета. Медицина, 14*(2), 98-104.

Khadra, H., Bakeer, M., Hauch, A., Hu, T., & Kandil, E. (2018). Hemostatic agent use in thyroid surgery: a meta-analysis. *Gland Surgery, 7*(Suppl 1), S34.

Khan, A. A., Koch, C. A., Van Uum, S., Baillargeon, J. P., Bollerslev, J., Brandi, M. L., . . . Shrayyef, M. Z. (2019). Standards of care for hypoparathyroidism in adults: a Canadian and International Consensus. *European Journal of Endocrinology, 180*(3), P1-P22.

Khan, Z. F., & Lew, J. I. (2019). Intraoperative parathyroid hormone monitoring in the surgical management of sporadic primary hyperparathyroidism. *Endocrinology and Metabolism, 34*(4), 327-339.

Khatiwada, A., & Harris, A. (2021). Use of pre-operative calcium and vitamin D supplementation to prevent post-operative hypocalcaemia in patients undergoing thyroidectomy: a systematic review. *The Journal of Laryngology & Otology*, 1-6.

Kim, D. (2017). The role of vitamin D in thyroid diseases. *International journal of molecular sciences, 18*(9), 1949.

Kim, D. H., Kim, S. W., Kang, P., Choi, J., Lee, H. S., Park, S. Y., . . . Lee, K. D. (2021). Near-infrared autofluorescence imaging may reduce temporary hypoparathyroidism in patients undergoing total thyroidectomy and central neck dissection. *Thyroid, 31*(9), 1400-1408.

Kim, E., Ramonell, K. M., Mayfield, N., & Lindeman, B. (2021). Parathyroid allotransplantation for the treatment of permanent hypoparathyroidism: A systematic review. *The American Journal of Surgery*.

Kim, H. K., Ha, E. J., Han, M., Lee, J., & Soh, E. Y. (2020). Reoperations for structurally persistent or recurrent disease after thyroidectomy: analysis via preoperative CT. *Scientific reports, 10*(1), 1-7.

Kim, S. H., Rhee, Y., Kim, Y. M., Won, Y. J., Noh, J., Moon, H., . . . Kim, S. G. (2020). Prevalence and complications of nonsurgical hypoparathyroidism in Korea: A nationwide cohort study. *PloS one, 15*(5), e0232842.

Kim, W. W., Chung, S.-H., Ban, E. J., Lee, C. R., Kang, S.-W., Jeong, J. J., . . . Park, C. S. (2015). Is preoperative vitamin D deficiency a risk factor for postoperative symptomatic hypocalcemia in thyroid cancer patients undergoing total thyroidectomy plus central compartment neck dissection? *Thyroid, 25*(8), 911-918.

Kim, Y. S., Erten, O., Kahramangil, B., Aydin, H., Donmez, M., & Berber, E. (2020). The impact of near infrared fluorescence imaging on parathyroid function after total thyroidectomy. *Journal of Surgical Oncology, 122*(5), 973-979.

Kim, Y., Kim, S. W., Lee, K. D., & Ahn, Y.-c. (2018). Real-time localization of the parathyroid gland in surgical field using Raspberry Pi during thyroidectomy: a preliminary report. *Biomedical optics express, 9*(7), 3391-3398.

Kong, D.-D., Wang, W., & Wang, M.-H. (2019). Superior parathyroid blood supply safety in thyroid cancer surgery: a randomized controlled trial. *International Journal of Surgery, 64*, 33-39.

Kritmetapak, K., & Pongchaiyakul, C. (2019). Parathyroid hormone measurement in chronic kidney disease: from basics to clinical implications. *international Journal of Nephrology, 2019*.

Kusuki, K., & Mizuno, Y. (2019). Hungry bone syndrome after thyroidectomy for thyroid storm. *BMJ Case Reports CP, 12*(10), e231411.

Lademann, F., Tsourdi, E., Hofbauer, L. C., & Rauner, M. (2020). Thyroid hormone actions and bone remodeling–the role of the wnt signaling pathway. *Experimental and Clinical Endocrinology & Diabetes, 128*(06/07), 450-454.

Laft, A. W., Jawad, I. S. M., & Numan, A. T. LEVEL OF THYROID HORMONE AFTER THYROID SURGERY.

Lanham-New, S. A., Hill, T. R., Gallagher, A. M., & Vorster, H. H. (2019). *Introduction to Human Nutrition*: Wiley.

Lebrun, B., De Block, C., & Jacquemyn, Y. (2020). Case report Hypocalcemia after thyroidectomy and parathyroidectomy in a pregnant woman.

Leung, E. K., Lee, C. C., Angelos, P., Kaplan, E. L., Grogan, R. H., Sarracino, D. A., . . . Yeo, K.-T. J. (2019). Analytical differences in intraoperative parathyroid hormone assays. *The Journal of Applied Laboratory Medicine, 3*(5), 788-798.

Levine, M. A. (2018). *Hypoparathyroidism, An Issue of Endocrinology and Metabolism Clinics of North America*: Elsevier Health Sciences.

Li, F., Rogers, R., & Rehman, S. U. (2021). Primary Hyperparathyroidism Presenting With Atrial Fibrillation and Calcified Pericardial Effusion. *Journal of the Endocrine Society, 5*(Supplement_1), A214-A214.

Licata, A. A., & Lerma, E. V. (2012). *Diseases of the Parathyroid Glands*: Springer New York.

Lim, S. T., Jeon, Y. W., Gwak, H., & Suh, Y. J. (2020). Incidence, risk factors, and clinical implications of delayed hypoparathyroidism on postoperative day two following total thyroidectomy for papillary thyroid carcinoma. *Endocrine Practice, 26*(7), 768-776.

Linos, D., & Chung, W. Y. (2012). *Minimally Invasive Thyroidectomy*: Springer Berlin Heidelberg.

Liu, R. H., Razavi, C. R., Chang, H.-Y., Tufano, R. P., Eisele, D. W., Gourin, C. G., & Russell, J. O. (2020). Association of hypocalcemia and magnesium disorders with thyroidectomy in commercially insured patients. *JAMA Otolaryngology–Head & Neck Surgery, 146*(3), 237-246.

Llorente, P. M., Laguado, E. A. G., Prats, M. A., Martínez, J. M. F., & Barrasa, A. G. (2021). Surgical approaches to thyroid. *Cirugía Española (English Edition), 99*(4), 267-275.

Lo, C. Y., & Tam, S. C. (2001). Parathyroid autotransplantation during thyroidectomy: documentation of graft function. *Archives of Surgery, 136*(12), 1381-1385.

Lombardi, C. P., Raffaelli, M., Princi, P., Santini, S., Boscherini, M., De Crea, C., . . . Zuppi, C. (2004). Early prediction of postthyroidectomy hypocalcemia by one single iPTH measurement. *Surgery, 136*(6), 1236-1241.

Lombardi, G., Ziemann, E., Banfi, G., & Corbetta, S. (2020). Physical activity-dependent regulation of parathyroid hormone and calcium-phosphorous metabolism. *International journal of molecular sciences, 21*(15), 5388.

Lorenz, K., Raffaeli, M., Barczyński, M., Lorente-Poch, L., & Sancho, J. (2020). Volume, outcomes, and quality standards in thyroid surgery: an evidence-based analysis—European Society of Endocrine Surgeons (ESES) positional statement. *Langenbeck's archives of surgery, 405*(4), 401-425.

Lorenz, K., Schneider, R., & Elwerr, M. (2020). Intraoperative measurement of parathyroid hormone in hyperparathyroidism. *Der Chirurg; Zeitschrift fur Alle Gebiete der Operativen Medizen, 91*(6), 448-455.

Luster, M., Duntas, L. H., & Wartofsky, L. (2019). *The Thyroid and Its Diseases: A Comprehensive Guide for the Clinician*: Springer International Publishing.

Macksey, L. (2011). *Surgical Procedures and Anesthetic Implications*: Jones & Bartlett Learning.

MAHAFFEE, D. D., COOPER, C. W., RAMP, W. K., & ONTJES, D. A. (1982). Magnesium promotes both parathyroid hormone secretion and adenosine 3′, 5′-monophosphate production in rat parathyroid tissues and reverses the inhibitory effects of calcium on adenylate cyclase. *Endocrinology, 110*(2), 487-495.

Mahyoub, A., Aljohani, A. A., Althobaiti, A. J., Alharbi, S. S., Alahmary, A. A., Algarni, R. S., . . . Alqubaishi, A. H. (2021). Recurrent and superior laryngeal nerve injury in thyroid surgery: literature review. *International Journal of Community Medicine and Public Health, 8*(2), 862.

Mak, N. T., Li, J., Vasilyeva, E., Hiebert, J., Guo, M., Lustig, D., . . . Wiseman, S. M. (2020). Intraoperative parathyroid hormone measurement during parathyroidectomy for treatment of primary hyperparathyroidism: When should you end the operation? *The American Journal of Surgery, 219*(5), 785-789.

Malik, M. Z., Mirza, A. A., Farooqi, S. A., Chaudhary, N. A., Waqar, M., & Bhatti, H. W. (2019). Role of preoperative administration of vitamin D and calcium in postoperative transient hypocalcemia after total thyroidectomy. *Cureus, 11*(4).

Mallick, U. K., & Harmer, C. (2018). *Practical Management of Thyroid Cancer: A Multidisciplinary Approach*: Springer International Publishing.

Manatakis, D. K., Bakavos, A., Soulou, V. N., Dimakis, C., & Tseleni-Balafouta, S. (2019). Reactive C cell hyperplasia as an incidental finding after thyroidectomy for papillary carcinoma. *Hormones, 18*(3), 289-295.

Mancino, A. T., & Kim, L. T. (2017). *Management of Differentiated Thyroid Cancer*: Springer International Publishing.

Mandapathil, M., Lennon, P., Ganly, I., Patel, S. G., & Shah, J. P. (2019). Significance and management of incidentally diagnosed metastatic papillary thyroid carcinoma in cervical lymph nodes in neck dissection specimens. *Head & Neck, 41*(11), 3783-3787.

Margolick, J., Chen, W., & Wiseman, S. M. (2018). Systematic review and meta-analysis of unplanned reoperations, emergency department visits and hospital readmission after thyroidectomy. *Thyroid, 28*(5), 624-638.

Marimuthu, V., & Murugan, B. (2021). Study of the risk factors for post-operative hypocalcemia after thyroid surgery. *International Surgery Journal, 8*(7), 2085-2088.

Marino, P. L., & Sutin, K. M. (2012). *The ICU Book*: Wolters Kluwer Health.

Masood, S., Kanaan, S., & Khaddouj, M. (2019). Evaluation of Postoperative Complications Between Total and Subtotal Thyroidectomy For Multinodular Goiter. *Tishreen University Journal-Medical Sciences Series, 41*(6).

Mazoni, L., Matrone, A., Apicella, M., Piaggi, P., Saponaro, F., Borsari, S., . . . Rossi, P. (2022). *Risk factors for renal calcifications and determinants of hypercalciuria in patients with chronic, post-surgical hypoparathyroidism.* Paper presented at the Endocrine Abstracts.

McLeod, I. K., Arciero, C., Noordzij, J. P., Stojadinovic, A., Peoples, G., Melder, P. C., . . . Shriver, C. D. (2006). The use of rapid parathyroid hormone assay in predicting postoperative hypocalcemia after total or completion thyroidectomy. *Thyroid, 16*(3), 259-265.

McMurran, A., Blundell, R., & Kim, V. (2020). Predictors of post-thyroidectomy hypocalcaemia: a systematic and narrative review. *The Journal of Laryngology & Otology, 134*(6), 541-552.

Mears, J., & Treacy, M. (2020). Body fluids and electrolytes *Acute Nursing Care* (pp. 97-134): Routledge.

Mencio, M., Calcatera, N., Ogola, G., Mahady, S., Shiller, M., Roe, E., . . . Landry, C. (2020). *Factors contributing to unintentional parathyroidectomy during thyroid surgery.* Paper presented at the Baylor University Medical Center Proceedings.

Mercante, G., Anelli, A., Giannarelli, D., Giordano, D., Sinopoli, I., Ferreli, F., . . . Cristalli, G. (2019). Cost-effectiveness in transient hypocalcemia post-thyroidectomy. *Head & Neck, 41*(11), 3940-3947.

Metere, A., Biancucci, A., Natili, A., Intini, G., & Graves, C. E. (2021). PTH after Thyroidectomy as a Predictor of Post-Operative Hypocalcemia. *Diagnostics, 11*(9), 1733.

Mishra, A. K., Agarwal, A., Parameswaran, R., & Singh, K. R. (2022). *Endocrine Surgery: A South Asian Perspective*: CRC Press.

Mistry, J., & Rao, S. (2021). Trousseau's sign in a patient with a proximal high-output small-bowel stoma. *Indian Journal of Surgery, 83*(5), 1316-1317.

Modi, K., & Charpot, R. (2021). Assessment of risk factors for post-operative hypocalcemia after thyroid surgery. *International Journal of Surgery, 5*(4), 274-277.

Mohamed, A. A., Qureshi, A. S., & Mohamed, S. A. (2020). Journal of J Clinical Research and Reports.

Mokrysheva, N. G., & Krupinova, J. A. (2019). The history of the discovery of parathyroid glands, and their role in the body. *Annals of the Russian academy of medical sciences, 74*(1), 35-43.

Moran, K., Grigorian, A., Elfenbein, D., Schubl, S., Jutric, Z., Lekawa, M., & Nahmias, J. (2020). Energy vessel sealant devices are associated with decreased risk of neck hematoma after thyroid surgery. *Updates in Surgery, 72*(4), 1135-1141.

Mudry, A., & Orloff, L. A. Theodor Kocher, Nobel Prize winner for work in thyroid physiology, pathology and surgery, died more than 100 years ago.

Mutahar, Y. (2020). *An Approach to Hypercalcaemia in General Practice*: FS Publications.

Myers, E. N., & Snyderman, C. H. (2017). *Operative Otolaryngology E-Book: Head and Neck Surgery*: Elsevier Health Sciences.

Nagel, K., Hendricks, A., Lenschow, C., Meir, M., Hahner, S., Fassnacht, M., . . . Schlegel, N. (2022). Definition and diagnosis of postsurgical hypoparathyroidism after thyroid surgery: meta-analysis. *BJS open, 6*(5), zrac102.

Nasiri, S., Meshkati Yazd, S., Kamran, H., Kahrizi, M., Azhdari, M., & Shahriarirad, R. (2022). Autotransplantation of parathyroid tissue into subcutaneous subclavicular area following total parathyroidectomy in secondary hyperparathyroidism. *Journal of Endocrinological Investigation*, 1-7.

Nemade, S. V., Rokade, V. V., Pathak, N. A., Tiwari, S. S., & Sonkhedkar, S. J. (2014). Comparison between perioperative treatment with calcium and with calcium and vitamin D in prevention of post thyroidectomy hypocalcemia. *Indian Journal of Otolaryngology and Head & Neck Surgery, 66*(1), 214-219.

Nguyen, T. M. D., Tran, V. G., Nguyen, T. C. H., & Nguyen, B. N. (2021). Role of Intracellular Divalent Cations on the Adenylate Cyclase Activation by Human LH in mLTC-1 Leydig Cells. *Journal of Applied Biotechnology Reports, 8*(4), 370-374.

Nistor, C. E., Tsui, S., Kırali, K., Ciuche, A., Aresu, G., & Kocher, G. J. (2020). *Thoracic Surgery: Cervical, Thoracic and Abdominal Approaches*: Springer International Publishing.

Noordzij, J. P., Lee, S. L., Bernet, V. J., Payne, R. J., Cohen, S. M., McLeod, I. K., . . . Richards, M. L. (2007). Early prediction of hypocalcemia after thyroidectomy using parathyroid hormone: an analysis of pooled individual patient data from nine observational studies. *Journal of the American College of Surgeons, 205*(6), 748-754.

NUMBNESS, P. C. O. (2018). A 67-year-old woman with bilateral hand numbness. *Cleveland Clinic Journal of Medicine, 85*(3), 201.

Obiarinze, R., Fazendin, J., Iyer, P., Lindeman, B., & Chen, H. (2021). Intraoperative parathyroid hormone measurement facilitates outpatient thyroidectomy in children. *The American Journal of Surgery, 221*(4), 683-686.

Oertli, D., & Udelsman, R. (2012). *Surgery of the Thyroid and Parathyroid Glands*: Springer Berlin Heidelberg.

Oliveira, D. H. A. d., Huning, L. P., Belim, M. C., Rodrigues, P. F., Nagai, H. M., & Graf, H. (2021). Is there a place for measuring serum calcitonin prior to thyroidectomy in patients with a non-diagnostic thyroid nodule biopsy? *Archives of Endocrinology and Metabolism, 65*, 40-48.

Omerovic, S. (2019). Chvostek Sign.

Onset, F. (2019). EMERGENCY, AND THERAPEUTIC APPENDICES. *The Little Black Book of Neurology*, 210.

Pãduraru, D. N., Ion, D., Carsote, M., Andronic, O., & Bolocan, A. (2019). Post-thyroidectomy hypocalcemia-risk factors and management. *Chirurgia, 114*(5), 564-570.

Paladino, N. C., Guérin, C., Graziani, J., Morange, I., Loundou, A., Taïeb, D., & Sebag, F. (2021). Predicting risk factors of postoperative hypocalcemia after total thyroidectomy: is safe discharge without supplementation possible? A large cohort study. *Langenbeck's archives of surgery, 406*(7), 2425-2431.

Palermo, A., Sanesi, L., Colaianni, G., Tabacco, G., Naciu, A. M., Cesareo, R., . . . Mori, G. (2019). A novel interplay between irisin and PTH: from basic studies to clinical evidence in hyperparathyroidism. *The Journal of Clinical Endocrinology & Metabolism, 104*(8), 3088-3096.

Palmhag, D., Brydolf, J., Zedenius, J., Bränström, R., & Nilsson, I.-L. (2021). A single parathyroid hormone measurement two hours after a thyroidectomy reliably predicts permanent hypoparathyroidism. *Scandinavian Journal of Surgery, 110*(3), 322-328.

Palop, I. F., Martínez, C. F., Giménez, M. J. S., Samper, M. d. C. A., & Fuster, R. G. (2021). Assessment of the Seric Calcium and Parathormone Levels in Patients Underwent Hemithyroidectomy.

Panduranga Rao, S. U. (2022). Total thyroidectomy using intracapsular dissection: the technique, complications, and surgical outcomes. *The Egyptian Journal of Otolaryngology, 38*(1), 1-6.

Papanastasiou, A., Sapalidis, K., Mantalobas, S., Atmatzidis, S., Michalopoulos, N., Surlin, V., . . . Passos, I. (2019). Design of a predictive score to assess the risk of developing hypocalcemia after total thyroidectomy. A retrospective study. *International Journal of General Medicine, 12*, 187.

Parameswaran, R., & Agarwal, A. (2018). *Evidence-Based Endocrine Surgery*: Springer Singapore.

Patel, C., & Shetty, S. (2020). History and Evolution of Thyroid Surgery *Thyroid Surgery* (pp. 1-5): CRC Press.

Patel, K. N., Yip, L., Lubitz, C. C., Grubbs, E. G., Miller, B. S., Shen, W., . . . Fahey III, T. J. (2020a). The American Association of Endocrine Surgeons guidelines for the definitive surgical management of thyroid disease in adults. *Annals of surgery, 271*(3), e21-e93.

Patel, K. N., Yip, L., Lubitz, C. C., Grubbs, E. G., Miller, B. S., Shen, W., . . . Fahey III, T. J. (2020b). Executive summary of the American Association of Endocrine Surgeons guidelines for the definitive surgical management of thyroid disease in adults. *Annals of surgery, 271*(3), 399-410.

Patel, M., & Hu, E. W. (2020). Trousseau Sign.

Peissig, K., Condie, B. G., & Manley, N. R. (2018). Embryology of the parathyroid glands. *Endocrinology and Metabolism Clinics, 47*(4), 733-742.

Pelle, L. (2017). Evaluation of the role of polymorphisms within the xenobiotic metabolizing enzymes and acrylamide metabolism as risk factors for Differentiated Thyroid Carcinoma.

Pepe, J., Colangelo, L., Biamonte, F., Sonato, C., Danese, V. C., Cecchetti, V., . . . Ferrone, F. (2020). Diagnosis and management of hypocalcemia. *Endocrine, 69*(3), 485-495.

Pertsemlidis, D., Inabnet, W. B., & Gagner, M. (2017). *Endocrine Surgery*: CRC Press.

Pham-Huy, C., & Huy, B. P. (2022). *Food and Lifestyle in Health and Disease*: CRC Press.

Philips, R., Nulty, P., Seim, N., Tan, Y., Brock, G., & Essig, G. (2019). Predicting transient hypocalcemia in patients with unplanned parathyroidectomy after thyroidectomy. *American journal of otolaryngology, 40*(4), 504-508.

Phookan, J., Gupta, S., Saikia, N., Sarma, D., Mili, M. K., Gohain, M., & Dey, J. (2021). Proposal of New Key Step in Lateral Approach Thyroidectomy in Light of Comparison of Surgical Outcomes of Medial versus Lateral Approach Thyroidectomy: A Randomised Controlled Study. *International Journal of Otolaryngology, 2021*.

Pillai, S. S., Foster, C. A., & Ashraf, A. P. (2022). Approach to Neonatal Hypocalcemia. *Journal: Newborn*(1), 190-196.

Ponce de León-Ballesteros, G., Bonilla-Ramírez, C., Hernández-Calderón, F. J., Pantoja-Millán, J. P., Sierra-Salazar, M., Velázquez-Fernández, D., & Herrera, M. F. (2020). Mid-term and long-term impact of permanent hypoparathyroidism after total thyroidectomy. *World journal of surgery, 44*(8), 2692-2698.

Ponce de León-Ballesteros, G., Velázquez-Fernández, D., Hernández-Calderón, F. J., Bonilla-Ramírez, C., Pérez-Soto, R. H., Pantoja, J. P., . . . Herrera, M. F. (2019). Hypoparathyroidism after total thyroidectomy: importance of the intraoperative management of the parathyroid glands. *World journal of surgery, 43*(7), 1728-1735.

Prete, F., Panzera, P., Di Meo, G., Pasculli, A., Sgaramella, L., Calculli, G., . . . Gurrado, A. (2022). Risk factors for difficult thyroidectomy and postoperative morbidity do not match: retrospective study from an endocrine surgery academic referral centre. *Updates in Surgery*, 1-9.

Qin, Y., Sun, W., Wang, Z., Dong, W., He, L., Zhang, T., & Zhang, H. (2021). A meta-analysis of risk factors for transient and permanent hypocalcemia after total thyroidectomy. *Frontiers in oncology, 10*, 614089.

Qu, P., Wang, H., & Li, X. (2022). Correlation between blood loss during primary total knee arthroplasty and hypoalbuminemia and hypocalcemia after arthroplasty. *Chinese Journal of Tissue Engineering Research, 26*(3), 392.

Radakrishnan, A., Reddy, A. T., Dalal, P., Rastatter, J. C., Josefson, J. L., Samis, J. H., . . . Raval, M. V. (2021). Hypocalcemia prevention and management after thyroidectomy in children: A systematic review. *Journal of Pediatric Surgery, 56*(3), 526-533.

Rahim, I., Memon, M. A., Surahio, A. R., Mallah, M. Q., Sushel, C., & Abro, S. (2021). FREQUENCY OF HYPOCALCAEMIA AFTER SUBTOTAL THYROIDECTOMY. *Journal of Peoples University of Medical & Health Sciences Nawabshah.(JPUMHS), 11*(2), 88-91.

Rahman, M. Z. (2021). Effect of Parathyroid Hormone Level within One Hour of Total Thyroidectomy on Serum Calcium Level. *SAS J Surg, 11*, 632-640.

Rajamahendran, R. (2018). *SURGERY SIXER FOR NBE: 3rd Edition, 2018*: CBS Publishers & Distributors Private Limited.

Rajan, S., Ravindhran, B., George, B., Bantwal, G., Ayyar, V., & Mohan, L. N. (2020). Parathormone decline levels are better markers of symptomatic hypocalcemia following total thyroidectomy than parathormone alone. *Biomarkers in Medicine, 14*(12), 1121-1126.

Rajeswari, M. (2017). *Prospective Analysis of Clinical, Biochemical and Peroperative Factors Predicting Hypocalcemia in Patients Undergoing Total Thyroidectomy.* Madras Medical College, Chennai.

Ram, N., Khan, S. A., & Aziz, A. Chronic Hypocalcemia Complication, A Pictorial Presentation.

Randolph, G. W. (2020). *Surgery of the Thyroid and Parathyroid Glands E-Book*: Elsevier Health Sciences.

Randolph, G. W., Kamani, D., Wu, C.-W., & Schneider, R. (2021). Surgical anatomy and monitoring of the recurrent laryngeal nerve *Surgery of the thyroid and parathyroid glands* (pp. 326-359. e310): Elsevier.

Reddy, V., & Mohammad, A. (2022). Predictors of Hypocalcaemia Following Thyroidectomy. *European Journal of Molecular & Clinical Medicine, 9*(03), 2022.

Reinhart, H. A., Snyder, S. K., Stafford, S. V., Wagner, V. E., Graham, C. W., Bortz, M. D., & Wang, X. (2018). Same day discharge after thyroidectomy is safe and effective. *Surgery, 164*(4), 887-894.

Remer, L. F., Linhares, S. M., Scola, W. H., Khan, Z. F., & Lew, J. I. (2022). Transient Hypocalcemia After Total Thyroidectomy: The Obesity Paradox at Work? *Journal of Surgical Research, 278*, 93-99.

Richa, C. G., Issa, A. I., Echtay, A. S., & El Rawas, M. S. (2018). Idiopathic hypoparathyroidism and severe hypocalcemia in pregnancy. *Case reports in endocrinology, 2018*.

Richards, M. L., Bingener-Casey, J., Pierce, D., Strodel, W. E., & Sirinek, K. R. (2003). Intraoperative parathyroid hormone assay: an accurate predictor of symptomatic hypocalcemia following thyroidectomy. *Archives of Surgery, 138*(6), 632-636.

Rifai, N. (2017). *Tietz Textbook of Clinical Chemistry and Molecular Diagnostics - E-Book*: Elsevier Health Sciences.

Rivera, S., & Lock, B. (2008). The reptilian thyroid and parathyroid glands. *Veterinary Clinics of North America: Exotic Animal Practice, 11*(1), 163-175.

Root, A. W., & Levine, M. A. (2021). Disorders of Mineral Metabolism II. Abnormalities of Mineral Homeostasis in the Newborn, Infant, Child, and Adolescent *Sperling Pediatric Endocrinology* (pp. 705-813): Elsevier.
Rovena, B., Xheladin, D., Etmond, C., Leka, N., & Mitrushi, A. Location, Number and Morphology of Parathyroid Glands: An Anatomical Study in Surgical Series.
RUDE, R. K., OLDHAM, S. B., SHARP Jr, C. F., & SINGER, F. R. (1978). Parathyroid hormone secretion in magnesium deficiency. *The Journal of Clinical Endocrinology & Metabolism, 47*(4), 800-806.
Russell, J. O., Inabnet, W. B., & Tufano, R. P. (2020). *Transoral Neck Surgery*: Springer International Publishing.
Saha, S., & Goswami, R. (2019). Auditing the efficacy and safety of alfacalcidol and calcium therapy in idiopathic hypoparathyroidism. *The Journal of Clinical Endocrinology & Metabolism, 104*(4), 1325-1335.
Şahbaz, N. A., Akarsu, C., Dural, A. C., Gümüşoğlu, A. Y., Güzey, D., Çikot, M., . . . Alış, H. (2018). Impact of Age on Postoperative Hypocalcemia after Thyroidectomy.
Saint, S., & Chopra, V. (2018). *The Saint-Chopra Guide to Inpatient Medicine*: Oxford University Press.
Sakr, M. F. (2020). Post-Thyroidectomy Hypocalcemia *Thyroid Disease* (pp. 599-662): Springer.
Sakr, M. F. (2020). *Thyroid Disease: Challenges and Debates*: Springer International Publishing.
Sakr, M. F. (2022). *Parathyroid Gland Disorders: Controversies and Debates*: Springer International Publishing.
Sakr, M. F. (2022a). Parathyroid Glands: Historical Review *Parathyroid Gland Disorders* (pp. 1-10): Springer.
Sakr, M. F. (2022b). Parathyroid Transplantation *Parathyroid Gland Disorders* (pp. 287-315): Springer.
Sakr, M. F. (2022c). Physiology of the Parathyroid Glands *Parathyroid Gland Disorders* (pp. 39-45): Springer.
Sakr, M. F. (2022d). Post-thyroidectomy Hypocalcemia: Incidence and Risk Factors *Parathyroid Gland Disorders* (pp. 251-271): Springer.
Sakr, M. F. (2022e). Post-thyroidectomy Hypocalcemia: Prevention *Parathyroid Gland Disorders* (pp. 277-285): Springer.
Sala, D. T., Muresan, M., Muresan, S., Titus, C. I., Darie, R., & Neagoe, R. M. (2019). A prospective follow-up study on completion thyroidectomy for well-differentiated thyroid cancer. *Ann. Ital. Chir, 90*(1), 14-20.
Saleem, R. B., Saleem, M. B., & Saleem, N. B. (2018). Impact of completion thyroidectomy timing on post-operative complications: a systematic review and meta-analysis. *Gland Surgery, 7*(5), 458.
Sanabria, A., Kowalski, L. P., & Tartaglia, F. (2018). Inferior thyroid artery ligation increases hypocalcemia after thyroidectomy: A meta-analysis. *The Laryngoscope, 128*(2), 534-541.
Sanabria, A., Kowalski, L. P., Nixon, I., Angelos, P., Shaha, A., Owen, R. P., . . . Ferlito, A. (2019). Methodological quality of systematic reviews of intraoperative neuromonitoring in thyroidectomy: a systematic review. *JAMA Otolaryngology–Head & Neck Surgery, 145*(6), 563-573.
Sanabria, A., Rojas, A., & Arevalo, J. (2019). Meta-analysis of routine calcium/vitamin D3 supplementation versus serum calcium level-based

strategy to prevent postoperative hypocalcaemia after thyroidectomy. *Journal of British Surgery, 106*(9), 1126-1137.

Santrac, N., & Dzodic, R. (2019). In situ preservation of parathyroid glands during thyroid surgery for prevention of hypoparathyroidism. *European Journal of Surgical Oncology, 45*(2), e128.

Sapmaz, A., & Kılıç, M. Ö. (2020). The effect of truncal/terminal ligation of inferior thyroid artery on hypocalcemia after total thyroidectomy. *Indian Journal of Surgery, 82*(6), 1137-1140.

Sasi, M., Shreyamsa, M., Garg, S., Enny, L., Singh, K. R., Rana, C., . . . Mishra, A. (2022). Role of Preoperative Calcium and Vitamin D Supplementation in Preventing Post-total Thyroidectomy Hypocalcemia. *World Journal of Endocrine Surgery, 14*(1), 7-14.

Schnur, J., Sinawe, H., Yoham, A. L., & Casadesus, D. (2021). Trousseau's sign and QT prolongation in hypocalcaemia. *BMJ Case Reports CP, 14*(3), e240260.

Sehnke, N., Schwarz, K., & Goretzki, P. (2018). cIONM in intrathoracic goiter–different decision of sternotomy.

Semrad, T. J., Keegan, T. H., Semrad, A., Brunson, A., & Farwell, D. G. (2018). Predictors of neck reoperation and mortality after initial total thyroidectomy for differentiated thyroid cancer. *Thyroid, 28*(9), 1143-1152.

Sessa, L., De Crea, C., Zotta, F., Cerviere, M. P., Gallucci, P., Princi, P., . . . Raffaelli, M. (2022). Post-thyroidectomy hypocalcemia: Is a routine preferable over a selective supplementation? *The American Journal of Surgery, 223*(6), 1126-1131.

Sharif, S. B., Ali, M. S., Rahman, M., Siddique, T. B., & Rahman, A. (2018). Parathyroid hormone assay in total thyroidectomy. *KYAMC Journal, 9*(2), 43-47.

Shen, C.-L., Wu, Y.-H., Zhang, T.-H., & Tu, L.-H. (2022). Dihydrocaffeic Acid-Decorated Iron Oxide Nanomaterials Effectively Inhibit Human Calcitonin Aggregation. *ACS omega*.

Shi, K.-l., Guo, J.-X., Zhao, H.-m., Hong, H., Yang, C.-z., Wu, Y.-h., & Du, L.-j. (2020). The effect of levetiracetam and oxcarbazepine monotherapy on thyroid hormones and bone metabolism in children with epilepsy: a prospective study. *Epilepsy & Behavior, 113*, 107555.

Shifrin, A. (2020). Brief overview of calcium, vitamin D, parathyroid hormone metabolism, and calcium-sensing receptor function. *Advances in Treatment and Management in Surgical Endocrinology*, 63-70.

Shifrin, A. L. (2021). *Endocrine Emergencies, E-Book*: Elsevier Health Sciences.

*Short Textbook of Surgery*. (2010). Jaypee Brothers Medical Publishers Pvt. Limited.

Sidani, M., Islam, A., & Nwariaku, F. (2022). Beyond the standard preoperative evaluation: The impact of functional dependency on complications after thyroidectomy. *The American Journal of Surgery*.

Sierra, M., Herrera, M. F., Herrero, B., Jiménez, F., Sepúlveda, J., Lozano, R. R., . . . Correa-Rotter, R. (1998). Prospective biochemical and scintigraphic evaluation of autografted normal parathyroid glands in patients undergoing thyroid operations. *Surgery, 124*(6), 1005-1010.

Singer, M. C., & Terris, D. J. (2021). *Innovations in Modern Endocrine Surgery*: Springer International Publishing.

Sitges-Serra, A. (2021). Etiology and diagnosis of permanent hypoparathyroidism after total thyroidectomy. *Journal of clinical medicine, 10*(3), 543.

Sitges-Serra, A., Lorente-Poch, L., & Sancho, J. (2018). Parathyroid autotransplantation in thyroid surgery. *Langenbeck's archives of surgery, 403*(3), 309-315.

Sittel, C., & Guntinas-Lichius, O. (2017). *Neurolaryngology*: Springer International Publishing.

Slough, C. M., Liddy, W., Brooks, J., Kaplan, E. L., Bura, M., Romanchishen, A. F., . . . Randolph, G. W. (2021). History of thyroid and parathyroid surgery *Surgery of the thyroid and parathyroid glands* (pp. 2-14. e12): Elsevier.

Sormaz, I. C., Iscan, A. Y., Ozgur, I., Karakus, S., Tunca, F., Senyurek, Y. G., & Terzioglu, T. (2021). The impact of postoperative percent change of parathormone level from baseline value on the rate of hypocalcemia after total thyroidectomy. *International Surgery, 105*(1-3), 291-299.

Soylu, S., & Teksoz, S. (2020). Earlier Prediction of Hypocalcemia by Postoperative Second Hour Parathyroid Hormone Level after Total Thyroidectomy. *Acta Endocrinologica (Bucharest), 16*(2), 250.

Spartalis, E., Ntokos, G., Georgiou, K., Zografos, G., Tsourouflis, G., Dimitroulis, D., & Nikiteas, N. I. (2020). Intraoperative indocyanine green (ICG) angiography for the identification of the parathyroid glands: current evidence and future perspectives. *in vivo, 34*(1), 23-32.

Spartalis, E., Thanassa, A., Athanasiadis, D. I., Schizas, D., Athanasiou, A., Zografos, G. N., . . . Nikiteas, N. (2019). Post-thyroidectomy hypocalcemia in patients with history of bariatric operations: current evidence and management options. *in vivo, 33*(4), 1373-1379.

Spinelli, C., Ghionzoli, M., Bertocchini, A., Sanna, B., Plessi, C., Strambi, S., . . . Antonelli, A. (2022). Factors associated with postoperative hypocalcemia following thyroidectomy in childhood. *Pediatric Blood & Cancer*, e29576.

Springer, C., & Nappe, T. M. (2019). Anticonvulsants toxicity.

Srinivasan, D. K., Jayabharathi, K., Chandrika, M., Dheen, S. T., Bay, B. H., & Parameswaran, R. (2022). Embryology and Surgical Anatomy: Thyroid and Parathyroid Glands *Endocrine Surgery* (pp. 10-16): CRC Press.

Stack, B. C., & Bodenner, D. L. (2016). *Medical and Surgical Treatment of Parathyroid Diseases: An Evidence-Based Approach*: Springer International Publishing.

Stipanuk, M. H., & Caudill, M. A. (2018). *Biochemical, Physiological, and Molecular Aspects of Human Nutrition - E-Book*: Elsevier Health Sciences.

Stojanovska, N., Velickova, N., Biljali, S., Dzemile, J., Mechevska-Jovchevska, J., & Iliovski, N. (2021). Urinary copper, biochemical marker for diagnostics and biomonitoring of patients with Wilson's disease. *Medicus, 26*(3), 316-321.

Suh, I., & Shen, W. T. (2016). Total Thyroidectomy and Thyroid Lobectomy *Illustrative Handbook of General Surgery* (pp. 3-15): Springer.

Sumukha, S. R. (2020). The advantage of near-total thyroidectomy to avoid postoperative hypoparathyroidism in benign multinodular goiter. *International Journal of Surgery, 4*(3), 205-207.

Sywak, M., Prichard, R., & Delbridge, L. (2021). Reoperation for Benign Thyroid Disease *Surgery of the Thyroid and Parathyroid Glands* (pp. 89-98. e84): Elsevier.

Tageldin, N., & Martin, A. (2020). Thyroid, parathyroid hormones and calcium homeostasis. *Anaesthesia & Intensive Care Medicine, 21*(11), 599-603.

Tartaglia, F., Giuliani, A., Sgueglia, M., Biancari, F., Juvonen, T., & Campana, F. P. (2005). Randomized study on oral administration of calcitriol to prevent symptomatic hypocalcemia after total thyroidectomy. *The American Journal of Surgery, 190*(3), 424-429.

Taterra, D., Wong, L. M., Vikse, J., Sanna, B., Pękala, P., Walocha, J., . . . Henry, B. M. (2019). The prevalence and anatomy of parathyroid glands: a meta-analysis with implications for parathyroid surgery. *Langenbeck's archives of surgery, 404*(1), 63-70.

Tausanovic, K. M., Zivaljevic, V. R., Zorić, G. V., Jovanovic, M. D., Stepanovic, B. G., Milenkovic, M. G., & Paunovic, I. R. (2021). Predictive Value of Calcium Test for Preoperative Diagnosis of Medullary Thyroid Carcinoma in Patients With Moderately Elevated Basal Calcitonin. *Endocrine Practice, 27*(11), 1077-1081.

Tecilazich, F., Formenti, A. M., Frara, S., Giubbini, R., & Giustina, A. (2018). Treatment of hypoparathyroidism. *Best Practice & Research Clinical Endocrinology & Metabolism, 32*(6), 955-964.

Teisseyre, M., Moranne, O., & Renaud, S. (2021). Late diagnosis of chronic hypocalcemia due to autoimmune hypoparathyroidism. *BMJ Case Reports CP, 14*(6), e243299.

Terris, D. J., & Duke, W. S. (2016). *Thyroid and Parathyroid Diseases: Medical and Surgical Management*: Thieme.

Testa, R. M., Martinelli, S., & Pacini, F. (2018a). Diagnosis and Treatment. *Clinical Applications of Nuclear Medicine Targeted Therapy*, 1.

Testa, R. M., Martinelli, S., & Pacini, F. (2018b). Diagnosis and Treatment of Hyperthyroidism *Clinical Applications of Nuclear Medicine Targeted Therapy* (pp. 3-17): Springer.

Thachil, A. P., Joseph, C. S., & David, S. K. S. (2021). Is serum phosphorous level an early indicator of post-operative hypocalcemia after total thyroidectomy? A prospective analysis. *International Surgery Journal, 8*(10), 2935-2939.

THAKUR, K. (2021). *POST-OPERATIVE SERUM PARATHYROID HORMONE LEVELS AS A PREDICTOR OF HYPOCALCEMIA IN PATIENTS UNDERGOING TOTAL THYROIDECTOMY.* SDUAHER.

Tinawi, M. (2021). Disorders of calcium metabolism: hypocalcemia and hypercalcemia. *Cureus, 13*(1).

Tjahjono, R., Nguyen, K., Phung, D., Riffat, F., & Palme, C. E. (2021). Methods of identification of parathyroid glands in thyroid surgery: A literature review. *ANZ Journal of Surgery, 91*(9), 1711-1716.

Torabi, S. J., Avery, J. M., Salehi, P. P., & Lee, Y. (2020). Risk factors and effects of hypocalcemia prior to discharge following thyroidectomy. *American journal of otolaryngology, 41*(3), 102420.

Tsai, S. D., Mostoufi-Moab, S., Bauer, S., Kazahaya, K., Hawkes, C. P., Adzick, N. S., & Bauer, A. J. (2019). Clinical utility of intraoperative parathyroid hormone measurement in children and adolescents undergoing total thyroidectomy. *Frontiers in Endocrinology, 10*, 760.

Tsai, S.-H., Chien, S.-C., Nguyen, P.-A., Chien, P.-H., Ma, H.-P., Asdary, R. N., . . . Iqbal, U. (2019). Incidences of hypothyroidism associated with surgical procedures for thyroid disorders: A nationwide population-based study. *Frontiers in pharmacology, 10*, 1378.

Tsourdi, E., Lademann, F., & Siggelkow, H. (2018). Impact of thyroid diseases on bone. *Der Internist, 59*(7), 661-667.

Unsal, I. O., Calapkulu, M., Sencar, M. E., Hepsen, S., Sakiz, D., Ozbek, M., & Cakal, E. (2020). Preoperative vitamin D levels as a predictor of transient hypocalcemia and hypoparathyroidism after parathyroidectomy. *Scientific reports, 10*(1), 1-6.

Vakharia, J. D., & Topor, L. S. (2021). Hypocalcemia *Endocrine Conditions in Pediatrics* (pp. 29-38): Springer.

Van Slycke, S., Van Den Heede, K., Bruggeman, N., Vermeersch, H., & Brusselaers, N. (2021). Risk factors for postoperative morbidity after thyroid surgery in a PROSPECTIVE cohort of 1500 patients. *International Journal of Surgery, 88*, 105922.

Van Slycke, S., Van Den Heede, K., Brusselaers, N., & Vermeersch, H. (2021). Feasibility of autofluorescence for parathyroid glands during thyroid surgery and the risk of hypocalcemia: first results in Belgium and review of the literature. *Surgical Innovation, 28*(4), 409-418.

Vasileiadis, I., Charitoudis, G., Vasileiadis, D., Kykalos, S., & Karatzas, T. (2018). Clinicopathological characteristics of incidental parathyroidectomy after total thyroidectomy: the effect on hypocalcemia. A retrospective cohort study. *International Journal of Surgery, 55*, 167-174.

Vasudev, V., & AV, A. K. (2020). Serum calcium slope is a predictor of post-thyroidectomy hypocalcemia. *International Surgery Journal, 7*(12), 3976-3980.

Vibhatavata, P., Pisarnturakit, P., Boonsripitayanon, M., Pithuksurachai, P., Plengvidhya, N., & Sirinvaravong, S. (2020). Effect of preoperative vitamin D deficiency on hypocalcemia in patients with acute hypoparathyroidism after thyroidectomy. *International Journal of Endocrinology, 2020*.

Voruganti, M. R. (2022). Clinical study of postoperative complications of thyroidectomy. *International Journal of Surgery, 6*(1), 69-73.

WANG, C., DAI, Q., LI, J., FU, L., ZHENG, S., & QIU, X. (2021). Analysis of risk factors for symptomatic hypocalcemia after thyroid surgery. *International Journal of Surgery*, 179-184, F174.

Wang, J.-B., Sun, H.-L., Song, C.-Y., & Gao, L. (2015). Association between decreased serum parathyroid hormone after total thyroidectomy and persistent hypoparathyroidism. *Medical Science Monitor: International Medical Journal of Experimental and Clinical Research, 21*, 1223.

Waseem, T., Ahmed, S. Z., Baig, H., Ashraf, M. H., Azim, A., & Azim, K. M. (2021). Truncal vs Branch Ligation of Inferior Thyroid Arteries in Total Thyroidectomy: Does It Affect Postoperative Hypoparathyroidism? *Otolaryngology–Head and Neck Surgery, 164*(4), 759-766.

Weng, Y. j., Jiang, J., Min, L., Ai, Q., Chen, D. b., Chen, W. c., & Huang, Z. h. (2021). Intraoperative near-infrared autofluorescence imaging for hypocalcemia risk reduction after total thyroidectomy: Evidence from a meta-analysis. *Head & Neck, 43*(8), 2523-2533.

Wermers, R. A., & Abate, E. G. (2022). Medication-Induced Hypercalcemia *Hypercalcemia* (pp. 209-222): Springer.

Wilson, G., Nistor, M., & Beasley, N. (2022). The formulation of an enhanced recovery programme for patients undergoing laryngectomy. *The Journal of Laryngology & Otology*, 1-13.

Wilson, R. B., Erskine, C., & Crowe, P. J. (2000). Hypomagnesemia and hypocalcemia after thyroidectomy: prospective study. *World journal of surgery, 24*(6), 722-726.

Winter, W. E., & Harris, N. S. (2021). Disorders of calcium metabolism *Handbook of Diagnostic Endocrinology* (pp. 309-388): Elsevier.

Wojtczak, B., Aporowicz, M., Kaliszewski, K., & Bolanowski, M. (2018). Consequences of bleeding after thyroid surgery–analysis of 7805 operations performed in a single center. *Archives of medical science, 14*(2), 329-335.

Wondisford, F. E. (2020). *Essentials of Endocrinology and Metabolism: A Practical Guide for Medical Students*: Springer Nature.

Wong, A., Nabata, K., & Wiseman, S. M. (2022). Medullary thyroid carcinoma: a narrative historical review. *Expert Review of Anticancer Therapy, 22*(8), 823-834.

Xie, J., Guo, J., Kanwal, Z., Wu, M., Lv, X., Ibrahim, N. A., . . . Sun, Q. (2020). Calcitonin and bone physiology: in vitro, in vivo, and clinical investigations. *International Journal of Endocrinology, 2020*.

Xu, J., Hu, P., Zhang, X., Chen, J., Wang, J., Zhang, J., . . . Wang, Y. (2022). Magnesium implantation or supplementation ameliorates bone disorder in CFTR-mutant mice through an ATF4-dependent Wnt/β-catenin signaling. *Bioactive Materials, 8*, 95-108.

Xu, S.-Q., Ma, Y., Su, H.-W., Cheng, J.-F., & Zhou, Y.-X. (2019). Comparison Of The Effects Of Focus Harmonic Scalpel And Conventional Haemostasis On Parathyroid Function In Thyroid Surgery. *Journal of Ayub Medical College, Abbottabad: JAMC, 31*(4), 481-484.

Yamaguchi, S., Hamano, T., Oka, T., Kajimoto, S., Kubota, K., Yasuda, S., . . . Sakaguchi, Y. (2020). Hidden hypocalcemia as a risk factor for cardiovascular events and all-cause mortality among patients undergoing incident hemodialysis. *Scientific reports, 10*(1), 1-9.

Yamamoto, M., Onoda, N., Miyauchi, A., Fujishima, M., Hayashi, T., & Hirokawa, M. (2022). Gauze blotting technique: a novel method to identify parathyroid glands during thyroid surgery without tissue damage. *Endocrine Journal*, EJ22-0043.

Yan, H.-c., Xiang, C., Wang, Y., & Wang, P. (2021). Scarless endoscopic thyroidectomy (SET) lateral neck dissection for papillary thyroid carcinoma through breast approach: 10 years of experience. *Surgical endoscopy, 35*(7), 3540-3546.

Yao, L., Li, J., Li, M., Lin, C., Hui, X., Tamilselvan, D., . . . Ali, D. S. (2022). Parathyroid hormone therapy for managing chronic hypoparathyroidism: a systematic review and meta-analysis. *Journal of Bone and Mineral Research*.

Yu, A. S. L., Chertow, G. M., Luyckx, V., Marsden, P. A., Skorecki, K., & Taal, M. W. (2015). *Brenner and Rector's The Kidney E-Book*: Elsevier Health Sciences.

Yu, P., Chen, Y., Wang, Y., Liu, Y., Zhang, P., Guo, Q., . . . Tan, H. (2019). Pentapeptide-decorated silica nanoparticles loading salmon calcitonin for in vivo osteoporosis treatment with sustained hypocalcemic effect. *Materials Today Chemistry, 14*, 100189.

Ziai, H., Dixon, P., Berman, G., Campisi, P., & Wasserman, J. D. (2022). Incidental Parathyroidectomy Among Pediatric Patients Undergoing Thyroid Surgery. *The Laryngoscope*.

Zulkufli, N. S., Jamaluddin, F. A., & Yazid, T. N. T. (2020). Limitations of calculated ionised calcium & adjusted calcium in critically ill patients: Time to consider measured ionised calcium. *The Malaysian journal of pathology, 42*(3), 385-394.