

PREVALENCE AND PATHOPHYSIOLOGY OF POST-THYROIDECTOMY HYPOCALCAEMIA

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Abstract: Post-thyroidectomy hypocalcemia is a recognised and potentially significant complication arising from the surgical removal of the thyroid gland. The study's main objective is to find the prevalence and pathophysiology of post-thyroidectomy hypocalcemia. This prospective observational study was conducted in Civil Hospital Quetta from June 2021 to July 2022. A total of 162 patients undergoing thyroidectomy for various indications, including thyroid cancer, hyperthyroidism, and goiter, were enrolled in the study. Before surgery, baseline data were gathered, including demographic information, medical history, and preoperative serum calcium and parathyroid hormone (PTH) levels, from the 162 enrolled patients scheduled for thyroidectomy. Data were collected from 162 patients from both genders. The mean age of patients was 48.5 ± 8.2 years, with 70% female. The diagnoses included 40% with thyroid cancer, 30% with hyperthyroidism, and 30% with a large goiter. Preoperative serum calcium levels were 9.0 ± 0.5 mg/dL, parathyroid hormone (PTH) levels were 45 ± 9.80 pg/mL, and vitamin D levels were 25.5 ± 6.3 ng/mL. A history of hypocalcemia was noted in 5% of the participants. The mean serum calcium level was 9.0 mg/dL, with a standard deviation of 0.5. However, at 48 hours post-op, there was a decrease in the mean serum calcium level to 7.8 mg/dL, with a standard deviation of 0.7. It is concluded that the interaction between reduced serum calcium and parathyroid hormone levels highlights the immediate impact of surgery on calcium homeostasis.

Keywords: Post-Thyroidectomy Hypocalcemia, Pathophysiology, Serum Calcium Levels, Parathyroid Hormone (PTH)

Introduction

Post-thyroidectomy hypocalcemia is a recognised and potentially significant complication arising from the surgical removal of the thyroid gland. Thyroidectomy, a standard procedure for the treatment of thyroid disorders such as thyroid cancer, hyperthyroidism, or large goitres, involves the removal of all or part of the thyroid gland (Edufa and Balasubramanian, 2017). Hypocalcemia following thyroid surgery results from the accidental damage or removal of the parathyroid glands, which play a crucial role in calcium homeostasis (Chen et al., 2021).

The prevalence and pathophysiology of post-thyroidectomy hypocalcemia have garnered substantial attention due to its impact on patient recovery and quality of life. The parathyroid glands, situated adjacent to the thyroid, regulate calcium levels by secreting parathyroid hormone (PTH) (Alqahtani et al., 2021). Disruption of these glands during thyroidectomy can lead to decreased PTH secretion, impairing calcium absorption and homeostasis. With advancements in anaesthesia, operative techniques, antisepsis, surgical instruments, and an enhanced understanding of thyroid anatomy and physiology, thyroid surgery is now considered safe (Alqahtani et al., 2020). However, complications following thyroid surgery remain possible. These complications encompass hypocalcemia, recurrent laryngeal nerve injury, hematoma, seroma, stridor, loss of high-pitched voice, thoracic duct injury, wound

infection, and tracheal injury. Experienced surgeons, as indicated by a higher surgical volume of procedures performed per year, tend to encounter such complications less frequently. Hypocalcemia and recurrent laryngeal nerve injury emerge as the most commonly encountered complications (Al-Qurayshi et al., 2016).

Post-thyroidectomy complications may be associated with specific risk factors, including age, sex, increased gland size, type of thyroid disease, presence of fibrosis and inflammation, extent of thyroidectomy, and lymph node dissection (Al-Qurayshi et al., 2016). According to a study conducted by Eismontas et al., advanced age, the presence of comorbidities, and progressive disease serve as significant risk factors for post-thyroidectomy complications, particularly in cases of thyroid cancer (Eismontas et al., 2018).

Methodology

The prospective observational study was carried out at Civil Hospital Quetta over a period spanning from June 2021 to July 2022. A cohort of 162 patients who underwent thyroidectomy for a range of indications, including thyroid cancer, hyperthyroidism, and goitre, were included in the study.

Inclusion criteria stipulated that patients must be between 18 and 75 years old and scheduled to undergo

thyroidectomy. Exclusion criteria were applied to patients with preexisting hypocalcemia, a history of parathyroid disorders, or those undergoing concomitant surgeries that could impact calcium homeostasis.

Before surgery, baseline data were gathered, including demographic information, medical history, and preoperative serum calcium and parathyroid hormone (PTH) levels, from the 162 enrolled patients scheduled for thyroidectomy. Surgical details, such as the extent of thyroidectomy, identification and preservation of parathyroid glands, and any intraoperative complications, were meticulously documented. Postoperatively, participants were monitored at regular intervals (e.g., 6 hours, 24 hours, 48 hours, and seven days) for serum calcium and PTH levels. Clinical parameters, encompassing symptoms of hypocalcemia and signs such as Chvostek's and Trousseau's, were also assessed. The definition of post-thyroidectomy hypocalcemia, based on serum calcium levels falling below the normal reference range within 48 hours after surgery, guided the identification of cases.

Data were collected and analysed using SPSS v29.0. Data with a normal distribution were presented as mean ± standard deviation, and a one-way analysis of variance was conducted to analyse these data. The likelihood of post-thyroidectomy hypocalcemia was assessed through multivariate binary logistic regression analysis.

Results

Data were collected from 162 patients from both genders. The mean age of patients was 48.5 ± 8.2 years, with 70% female. The diagnoses included 40% with thyroid cancer, 30% with hyperthyroidism, and 30% with a large goitre. Preoperative serum calcium levels were 9.0 ± 0.5 mg/dL, parathyroid hormone (PTH) levels were 45 ± 9.80 pg/mL, and vitamin D levels were 25.5 ± 6.3 ng/mL. A history of hypocalcemia was noted in 5% of the participants. (Table 1)

Table 1: Demographic data of patients

Demographic/Baseline Characteristic	Mean±SD (or Percentage)
Age (years)	48.5±8.2
Gender (Female)	70%
Diagnosis	
- Thyroid Cancer	40%
- Hyperthyroidism	30%
- Large Goiter	30%
Serum Calcium (Preoperative)	9.0±0.5 mg/dL
Parathyroid Hormone (PTH) (Preoperative)	45±9.80 pg/mL
Vitamin D Levels (ng/mL)	25.5±6.3
History of Hypocalcemia	5%

Table 2 shows the prevalence of post-thyroidectomy hypocalcemia in patients; 25% shows post-thyroidectomy hypocalcemia.

Table 2: Prevalence of post-thyroidectomy hypocalcemia

Post-Thyroidectomy Hypocalcemia	Total
Yes	25%
No	75%

The mean serum calcium level was 9.0 mg/dL with a standard deviation 0.5. However, at 48 hours post-op, there was a decrease in the mean serum calcium level to 7.8 mg/dL, with a standard deviation of 0.7. Regarding parathyroid hormone (PTH) levels, the preoperative mean was 45 pg/mL with a standard deviation 10. After 6 hours post-op, there was a noticeable decline in the mean PTH level to 12 pg/mL, accompanied by a standard deviation of 5. (Table 3)

Table 3: Serum PTH and calcium levels

Serum Calcium levels	Mean (mg/dL)
Preoperative	9.0±0.5
48 Hours Post-op	7.8±0.7
PTH levels	Mean (pg/mL)
Preoperative	45±10.0
6 Hours Post-op	12±5.0

The prevalence of hypocalcemia varied with different surgical variables. A total of 25% of patients experienced hypocalcemia, and this was significantly associated with the extent of thyroidectomy (p-value: 0.02). In cases where there was inadequate preservation of parathyroid glands, the prevalence of hypocalcemia increased to 30%, and this association was statistically significant with a p-value of 0.01. Additionally, correlation analysis revealed a strong negative correlation (correlation coefficient: -0.75) between postoperative serum calcium levels and the decline in parathyroid hormone (PTH) levels, with a highly significant p-value of less than 0.001.(Table 4)

Table 4: Association with surgical variables and correlation co-efficient

Surgical Variable	Prevalence of Hypocalcemia	p-value
Extent of Thyroidectomy	Total: 25%	0.02
Identification of Parathyroid Glands	Inadequate Preservation: 30%	0.01
Correlation Coefficient		p-value
Postoperative Serum Calcium vs. Decline in PTH Levels	-0.75	<0.001

Discussion

The observed prevalence of post-thyroidectomy hypocalcemia, affecting 25% of patients, underscores the significance of this complication in the postoperative period. Clinical symptoms, including tingling sensations and muscle cramps, were consistent with the literature, emphasizing the importance of vigilant symptom monitoring (Azadbakht et al., 2021; Päduraru et al., 2019). The significant reduction in postoperative serum calcium levels (7.8 mg/dL) and PTH levels (12 pg/mL) highlights the immediate impact of thyroidectomy on calcium homeostasis. The strong negative correlation between these parameters further reinforces the interplay between serum calcium and PTH in the post-thyroidectomy setting (McMurran et al., 2020).

Thyroidectomy, encompassing total thyroidectomy (TT) and subtotal thyroidectomy, is a widely employed and generally safe surgical procedure (Sakr, 2022). Despite its

routine use, the occurrence of significant complications such as inadvertent parathyroidectomy, postoperative bleeding, hypocalcemia, and recurrent laryngeal nerve injury poses potential threats to the postoperative quality of life for patients (van Dijk et al., 2024). The prevalence of postoperative hypocalcemia, the most common complication following thyroidectomy, ranges from 7% to 51%, with a 6-month prevalence of 3.6% and a permanent prevalence of 1.5–4%. While patient concerns primarily revolve around the quality of life, extended hospital stays and an unfavourable prognosis are significant factors (Metere et al., 2021). Recent research has identified several risk factors for postoperative hypocalcemia, including perioperative parathyroid hormone (PTH) levels, inadvertent parathyroidectomy during thyroid resection, and postoperative levels of vitamin D and magnesium (Bezawada and MC, 2023; Jagadesan et al., 2020; Sangi et al., 2022).

Conclusion

It is concluded that the interaction between reduced serum calcium and parathyroid hormone levels highlights the immediate impact of surgery on calcium homeostasis. Surgical variables, such as the extent of thyroidectomy and parathyroid gland preservation, emerge as critical determinants, emphasising the need for precision in surgical techniques.

Declarations

Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department Concerned.

Consent for publication

Approved

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Conflict of interest

The authors declared absence of conflict of interest.

Author Contribution

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Coordination of collaborative efforts.

Conception of Study, Development of Research Methodology Design, Study Design, Review of manuscript, final approval of manuscript.

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Manuscript revisions, critical input.

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Manuscript revisions, critical input, drafting article.

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Data acquisition, analysis.

Coordination of collaborative efforts.

References

- Al-Qurayshi, Z., Robins, R., Hauch, A., Randolph, G. W., and Kandil, E. (2016). Association of surgeon volume with outcomes and cost savings following thyroidectomy: a national forecast. *JAMA otolaryngology-head & neck surgery* **142**, 32-39.
- Alqahtani, S. M., Alatawi, A. S., Alalawi, Y. S., Alatawi, A. S., and Alalawi, Y. (2021). Post-thyroidectomy hypocalcemia: a single-center experience. *Cureus* **13**.
- Alqahtani, S. M., Almussallam, B., Alatawi, A. S., Alsuhaimi, N. A., Albalawi, A., Albalawi, N. S., Alzahrani, A. M., and Alalawi, Y. (2020). Post-thyroidectomy complications and risk factors in Tabuk, Saudi Arabia: a retrospective cohort study. *Cureus* **12**.
- Azadbakht, M., Emadi-Jamali, S. M., and Azadbakht, S. (2021). Hypocalcemia following total and subtotal thyroidectomy and associated factors. *Annals of Medicine and Surgery* **66**, 102417.
- Bezawada, R., and MC, N. (2023). The Incidence of Hypocalcemia following Total Thyroidectomy: A Retrospective Study. *SVU-International Journal of Medical Sciences* **6**, 457-464.
- Chen, Z., Zhao, Q., Du, J., Wang, Y., Han, R., Xu, C., Chen, X., and Shu, M. (2021). Risk factors for postoperative hypocalcaemia after thyroidectomy: A systematic review and meta-analysis. *Journal of International Medical Research* **49**, 0300060521996911.
- Edafe, O., and Balasubramanian, S. P. (2017). Incidence, prevalence and risk factors for post-surgical hypocalcaemia and hypoparathyroidism. *Gland surgery* **6**, S59.
- Eismontas, V., Slepavicius, A., Janusonis, V., Zeromskas, P., Beisa, V., Strupas, K., Dambrasukas, Z., Gulbinas, A., and Martinkenas, A. (2018). Predictors of postoperative hypocalcemia occurring after a total thyroidectomy: Results of prospective multicenter study. *BMC surgery* **18**, 1-12.
- Jagadesan, A., Sivakumar, N., Arjunan, S., and Parthipan, G. (2020). Growth, structural, optical, thermal and dielectric behaviour of a novel organic nonlinear optical (NLO) material: Benzimidazolium trichloroacetate monohydrate. *Optical Materials* **109**, 110285.
- McMurrin, A., Blundell, R., and Kim, V. (2020). Predictors of post-thyroidectomy hypocalcaemia: a systematic and narrative review. *The Journal of Laryngology & Otolaryngology* **134**, 541-552.
- Metere, A., Biancucci, A., Natili, A., Intini, G., and Graves, C. E. (2021). PTH after thyroidectomy as a predictor of post-operative hypocalcemia. *Diagnostics* **11**, 1733.
- Păduraru, D. N., Ion, D., Carsote, M., Andronic, O., and Bolocan, A. (2019). Post-thyroidectomy hypocalcemia-risk factors and management. *Chirurgia* **114**, 564-570.

- Sakr, M. F. (2022). Post-thyroidectomy Hypocalcemia: Incidence and Risk Factors. In "Parathyroid Gland Disorders: Controversies and Debates", pp. 251-271. Springer.
- Sangi, M., Shaikh, A., Fatima, S., Bhatti, N., Ali, M., and Aamir, A. (2022). Critical Analysis of the Frequency and Factors Leading to Hypocalcemia after Total/Near Total Thyroidectomy. *Pakistan Journal of Medical & Health Sciences* **16**, 290-290.
- van Dijk, S. P., van Driel, M. E., van Kinschot, C. M., Engel, M. F., Franssen, G. J., van Noord, C., Visser, W. E., Verhoef, C., Peeters, R. P., and van Ginhoven, T. M. (2024). Management of Postthyroidectomy Hypoparathyroidism and Its Effect on Hypocalcemia-Related Complications: A Meta-Analysis. *Otolaryngology–Head and Neck Surgery* **170**, 359-372.



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