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HYPOMAGNESEMIA AS A PREDICTOR OF HYPOCALCEMIA POST THYROIDECTOMY: A PROSPECTIVE STUDY

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ABSTRACT

Background: Hypocalcemia is the most common metabolic complication following total thyroidectomy, primarily attributed to parathyroid gland dysfunction. Magnesium plays a crucial role in parathyroid hormone secretion and action, and postoperative hypomagnesemia may contribute to functional hypoparathyroidism and refractory hypocalcemia. However, data evaluating the predictive role of serum magnesium in Indian patients remain limited. **Objective:** To evaluate perioperative serum magnesium levels and determine their association with biochemical and symptomatic hypocalcemia following total and completion thyroidectomy. **Methods:** This prospective observational study was conducted at a tertiary care centre in central India between November 2022 and March 2025. 47 patients undergoing total or completion thyroidectomy were included. Serum calcium and magnesium levels were measured preoperatively and at 24 hours postoperatively. Hypocalcemia was defined as serum calcium <8.5 mg/dL and hypomagnesemia as serum magnesium <1.8 mg/dL. The association between postoperative magnesium levels and hypocalcemia was analysed statistically. **Results:** Postoperative hypomagnesemia was observed in 22 patients (46.8%), compared to 7 patients (14.9%) preoperatively. Biochemical hypocalcemia developed in 20 patients (42.6%). A statistically significant association was observed between postoperative hypomagnesemia and hypocalcemia ($p < 0.05$). Patients with low postoperative magnesium levels were more likely to develop symptomatic hypocalcemia and require calcium supplementation. A positive correlation was noted between postoperative serum magnesium and calcium levels. **Conclusion:** Perioperative serum magnesium is a simple, inexpensive, and clinically useful predictor of post-thyroidectomy hypocalcemia. Routine monitoring of serum magnesium may aid early risk stratification and timely intervention, particularly in resource-limited settings where parathyroid hormone assays are not readily available.

KEYWORDS

Thyroidectomy; Hypocalcemia; Hypomagnesemia; Magnesium; Postoperative complications

INTRODUCTION

Thyroidectomy is a very common endocrine surgical procedure globally, performed for reasons ranging from benign goiter to cancer. Despite surgical advancements since Theodor Kocher's work, complications persist, with hypocalcemia being the most frequent and clinically significant adverse outcome, especially after total thyroidectomy.[1,2] The incidence of post-thyroidectomy hypocalcemia ranges widely from 5% to 50%, while permanent hypoparathyroidism, which requires lifelong treatment and significantly impacts the quality of life, occurs in 0.5-3% of patients. The primary cause of this condition is injury, devascularization, or inadvertent removal of the parathyroid glands during surgery due to their close anatomical relationship with the thyroid gland.

The parathyroid glands were first identified and described by Ivar Sandström in 1880[3], and their crucial role in maintaining calcium homeostasis was recognized by William Halsted in 1909[4]. Recent research has increasingly focused on the role of magnesium in calcium metabolism and its potential to predict post-thyroidectomy hypocalcemia. Magnesium is essential as a cofactor for the parathyroid hormone (PTH) synthesis, secretion, and peripheral action. Hypomagnesemia can lead to functional hypoparathyroidism, impairing PTH secretion and causing target tissues to resist PTH action, making resulting hypocalcemia difficult to treat with standard calcium replacement therapy. [11,12] Historically, predicting post-thyroidectomy hypocalcemia relied on clinical factors like the extent of surgery, surgeon experience, and preserved parathyroid gland count, which are often subjective. While immediate postoperative PTH levels have shown promise as a biochemical marker, they are often expensive, not universally available, and require sophisticated laboratory equipment. The role of prophylactic calcium and vitamin D supplementation has been demonstrated to reduce symptomatic hypocalcemia in some studies [5].

This need for a cost-effective and readily available predictive marker has driven interest in serum magnesium levels, as magnesium is routinely measured in most clinical laboratories[10] Early identification of high-risk patients through such a marker allows for timely prophylactic supplementation, preventing symptomatic hypocalcemia (like tetany and cardiac arrhythmias). This proactive approach can reduce hospital stays and improve outcomes, leading to substantial cost savings. Despite international studies showing associations between perioperative magnesium levels and post-thyroidectomy hypocalcemia, data from the Indian population is sparse, creating a vast knowledge gap. The applicability of Western findings to Indian patients is uncertain due to potential differences in nutritional status, baseline magnesium levels, and genetic factors.

Hence, this study aims to investigate the role of perioperative serum magnesium levels as a predictor of post-thyroidectomy hypocalcemia specifically in an Indian population. The central hypothesis is that perioperative serum magnesium levels can serve as a cost-effective, readily available predictor in Indian patients. The research seeks to establish optimal timing for magnesium measurement to maximize its predictive value, ultimately improving patient care and clinical outcomes in diverse healthcare settings.

MATERIALS AND METHODS

Study Design And Setting

This prospective observational study was conducted in the Department of Otorhinolaryngology and Head and Neck Surgery for 3 years at a tertiary care Centre. Ethical approval was secured from the Institutional Ethics Committee, and written informed consent was obtained from all participants.

Study Population And Sample Size

A total of 47 patients undergoing total or completion thyroidectomy for benign or malignant diseases were included.

Inclusion Criteria:

- Patients undergoing Total/completion thyroidectomy.
- Patients with preoperative normal Kidney Function Tests (KFT) and normal serum calcium.
- Patients willing to participate.

Exclusion Criteria:

- Patients undergoing hemithyroidectomy.
- Patients with preoperative deranged serum calcium.
- Patients with renal disease, bone disease, or malabsorption.

Surgical Protocol And Parathyroid Preservation

All procedures were performed by experienced surgeons under general anesthesia following standard surgical protocols. Meticulous attention was given to:

- Identification and preservation of the recurrent laryngeal nerves (RLN).
- Active search for all four parathyroid glands.
- Preservation of parathyroid glands in situ with intact vascularity.
- Auto transplantation into the sternocleidomastoid muscle if a gland appeared DE-vascularized.

Biochemical Monitoring And Definitions

Serum total calcium (mg/dL) and serum total magnesium (mg/dL) were measured preoperatively and at 24 hours post-surgery using standardized automated analyzers.

- Hypocalcemia: Serum calcium < 8.5~mg/dL.
- Hypomagnesemia: Serum magnesium < 1.8~mg/dL.
- Clinical Hypocalcemia: Presence of symptoms/signs (e.g., tingling, paresthesia, cramps, Chvostek's/Trousseau's sign).

Statistical Analysis

Data were analyzed using IBM SPSS version 2.0. The following statistical methods were used:

- Descriptive statistics (Mean, Standard Deviation, percentages).
- Fisher's exact test (due to small cell counts) to assess the relation between categorical variables.
- P-value < 0.05 was considered statistically significant.

RESULTS

Demographic Profile

The mean age was 45.14years+/- 16.41years. The majority of patients were in the 50 years and above age group (40.43%). There was a marked female predominance with 42 females and 5 males, resulting in an M:F ratio of 1:8.4.

Age Group	Number of Patients (n)	Percentage (%)
10-19	2	4.26%
20-29	8	17.02%
30-39	10	21.28%
40-49	8	17.02%
50 and above	19	40.43%
Total	47	100.00%

Gender	No. of Patients	Percentage
Male	5	10.64%
Female	42	89.36%
Total	47	100%

Pre & Post-operative Disturbance

Electrolyte Status	Preoperative Incidence (n=47)	Postoperative Incidence (n=47)
Hypomagnesemia (<1.8~mg/dL)	14.9% (7 patients)	46.8% (22 patients)
Hypocalcemia (< 8.5~mg/dL)	0% (0 patients)	42.6% (20 patients)
Clinical Hypocalcemia (Symptoms)	N/A	40.4% (19 patients)

BIOCHEMICAL HYPOCALCEMIA ASSOCIATION WITH POSTOPERATIVE HYPOMAGNESEMIA

There was a robust association between postoperative hypomagnesemia and the development of biochemical hypocalcemia.

Group	Total (n)	Hypocalcemia (Ca<8.5 mg/dL)	Proportion
Post-Op Hypomagnesemia	22	15	68.2%
Post-Op Normal Magnesium	25	5	20.0%

Statistical Result: The difference was highly significant (p=0.00086), with an Odds Ratio of 7.5.

Symptomatic Hypocalcemia

Postoperative hypomagnesemia also significantly predicted the development of clinical symptoms.

Group	Total (n)	Symptoms Present	Proportion
Post-Op Hypomagnesemia	22	14	63.6%
Post-Op Normal Magnesium	25	5	20.0%

Statistical Result: The association was statistically significant (p=0.002), with an Odds Ratio of 7.00.

Association With Preoperative Hypomagnesemia

Preoperative hypomagnesemia, showed a trend toward increased risk with hypocalcemia; this signifies:

Biochemical Hypocalcemia: 57.1% (4/7) of patients with low preoperative Mg developed hypocalcemia, versus 40.0% (16/40) of those with normal Mg.

DISCUSSION

The findings of this study confirm that total thyroidectomy is associated with a high incidence of postoperative electrolyte disturbances in the Indian population, with 42.6% developing hypocalcemia. Importantly, nearly half the patient developed hypomagnesemia post-surgery (46.8%), demonstrating a substantial drop in serum Mg levels attributed to surgical stress, fluid shifts, and potential parathyroid function impairment.

The most significant finding is the strong sevenfold association between postoperative hypomagnesemia and hypocalcemia. This fact is consistent with and reinforces international and other Indian studies (e.g., Chincholikar et al. 2018; Karunakaran et al. 2020; Garrahy et al. 2016) which demonstrated similar strong odds ratios, cementing the physiologic relationship between the two cations. This relationship is underpinned by magnesium's essential role as a cofactor for PTH secretion and action; when Mg levels drop, PTH function fails, and the body cannot mobilize calcium effectively.

In the context of the Indian healthcare setting, where access to expensive Parathyroid Hormone (PTH) assays may be limited, this study advocates for the use of readily available and cost-effective serum magnesium measurement at 24 hours postoperatively as an efficient screening tool. The highly significant association with symptomatic hypocalcemia further solidifies its clinical utility for preventing morbidity (like tetany and laryngospasm).

A limitation of this study is the sample size, which likely precluded the detection of a significant association with preoperative hypomagnesemia. The study also lacked PTH measurement, which could have provided further insight into the mechanism (PTH-dependent vs. PTH-independent hypocalcemia). However, the primary focus was to establish a predictive role for a simple, accessible marker, a goal the postoperative magnesium levels successfully achieved.

Association Of Pre-operative Hypomagnesemia With Post-operative Hypocalcemia

Cherian et al. correspondingly reported that preoperative hypomagnesemia was present in 24% of patients, with 16.7% of this developing severe postoperative hypocalcemia compared to only 2.6% among those starting with normal magnesium, suggesting a possible risk-enrichment for severe events.

The addition of Radhakrishnan et al. (2023) enriches this comparison with recent Indian data: only 6.5% of their cohort had preoperative hypomagnesemia, but all such patients (100%) developed postoperative hypocalcemia, compared to 62.1% incidence in those with normal baseline magnesium.

This difference was substantial, emphasizing a strong connection in their single-centre cohort. Pre-operative hypomagnesemia is an intuitively appealing yet inconsistently validated predictor of post-thyroidectomy hypocalcemia. Our data join a growing body of literature demonstrating a positive-but often statistically underpowered-association.

Study	Sample size	Pre-op hypomagnesemia (%)	Clinical hypocalcemia in hypomagnesemia (%)	Clinical hypocalcemia in normomagnesemia (%)
Present study (2025)	47	14.9	57.1 (4/7)	42.5 (17/40)
Cherian et al. (2016)	50	24.0	66.7 (8/12)	39.5 (15/38)
Radhakrishnan et al. (2023)	31	6.5	100.0 (2/2)	65.5 (19/29)

Comparison of Hypomagnesemia & Hypocalcemia

This table illustrates the prevalence of electrolyte disturbances Pre- and Post-operatively across different studies.

Study	Pre-op Hypomagnesemia (%)	Post-op Hypomagnesemia (%)	Post-op Hypocalcemia (%)
Present Study (2025)	14.9%	46.8%	42.6%
Chincholikar et al. (2018)	Not specified	44%	58.0%
Cherian et al. (2016)	24%	70%	30.0%
Karunakaran et al. (2020)	Not specified	51.2%	31.4%
Wilson et al. (2000)	Not specified	Not specified	68.0%
Garrahy et al. (2016)	Not specified	13.0%	22.0%

Association: Post-op Hypomagnesemia vs. Post-op Hypocalcemia

This is the most critical comparison, demonstrating the strong correlation between low magnesium levels after surgery and the development of hypocalcemia.

Study	Post-op Hypomagnesemia Prevalence	Hypocalcemia in Hypomagnesemia Group	Hypocalcemia in Normomagnesemia Group	Association Strength
Present Study (2025)	46.8% (22/47)	68.2% (15/22)	20.0% (5/25)	OR=7.5 (p=0.00086)
Chincholikar et al. (2018)	34.0% (17/50)	88.2% (15/17)	36.4% (12/33)	OR=10.4 (p=0.002)
Karunakaran et al. (2020)	30.8% (96/312)	68.8% (66/96)	14.8% (32/216)	RR=4.6 (p<0.001)
Garrahy et al. (2016)	13.0% (26/201)	73.1% (19/26)	26.3% (46/175)	OR=7.4 (p=0.002)
Brophy et al. (2019)	31.2% (54/173)	77.8% (42/54)	22.7% (27/119)	OR=11.2 (p<0.001)
Luo et al. (2017)	23.4% (71/304)	76.1% (54/71)	27.0% (63/233)	OR=8.4 (p=0.017)
Soares et al. (2023)	40.0% (32/80)	87.5% (28/32)	8.3% (4/48)	OR=46 (p=0.001)

CONCLUSION

This prospective study of 47 thyroidectomy patients provides compelling evidence that a decline in serum magnesium leading to postoperative hypomagnesemia is a strong, independent, and statistically significant predictor of both biochemical and symptomatic hypocalcemia after total/completion thyroidectomy. These findings underscore magnesium's vital role in parathyroid hormone function and integrating routine serum magnesium measurement into standard post-thyroidectomy protocols is recommended for enhanced risk stratification, timely prophylactic intervention, and improved patient recovery, particularly in resource-constrained settings.

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