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Impact of Immediate Post-Thyroidectomy Parathyroid Hormone Levels on Subsequent Serum Calcium Changes

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ABSTRACT

Background: Post-thyroidectomy hypocalcemia is a common complication, and immediate postoperative parathyroid hormone (PTH) levels may predict subsequent serum calcium changes. This study aimed to assess the impact of immediate post-thyroidectomy PTH levels on subsequent serum calcium levels. ***Methods:*** This cross-sectional study was conducted at the General Surgery and Otolaryngology Department, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, from January 2022 to December 2023. A total of 103 patients who underwent total thyroidectomy were enrolled. Immediate postoperative PTH levels were assessed, and serum calcium levels were measured at different postoperative intervals. ***Results:*** The study analyzed 103 patients undergoing total thyroidectomy. The mean age was 41.72±12.12 years, with 76.7% females. The primary indication was multinodular goiter (70.87%). Postoperatively, PTH significantly declined (p=0.001), correlating with hypocalcemia (r=0.310, p=0.001). A PTH cutoff of ≤14.4 pg/mL predicted hypocalcemia with 94.6% sensitivity and 100% specificity. Early postoperative PTH assessment is crucial for identifying at-risk patients and guiding calcium supplementation. ***Conclusion:*** Early postoperative PTH assessment is a reliable predictor of hypocalcemia following total thyroidectomy. A PTH threshold of ≤14.4 pg/mL demonstrated high sensitivity and specificity in identifying at-risk patients. Timely intervention with calcium supplementation can prevent complications, improving postoperative management and patient outcomes.

Keywords: Parathyroid hormone, Predictive biomarker. Post-thyroidectomy hypocalcemia, Serum calcium, Total thyroidectomy.

INTRODUCTION

Total thyroidectomy is a commonly performed surgical procedure for the management of benign and malignant thyroid disorders. Despite advancements in surgical techniques, post-thyroidectomy hypocalcemia remains a significant concern, affecting patient recovery and increasing hospital stays [1]. Hypocalcemia following total thyroidectomy is primarily attributed to inadvertent trauma, devascularization, or inadvertent removal of the parathyroid glands, leading to transient or permanent hypoparathyroidism [2,3]. Early identification of patients at risk for post-thyroidectomy hypocalcemia is crucial for timely intervention and improved patient outcomes. Parathyroid hormone (PTH) plays a central role in calcium homeostasis, and its levels decline rapidly following parathyroid gland dysfunction [4]. Several studies have demonstrated that measuring immediate postoperative PTH levels can serve as a reliable predictor of subsequent hypocalcemia, allowing for early calcium supplementation and reducing the need for prolonged hospital observation [5,6]. The accuracy of immediate postoperative PTH as a predictive marker has been widely studied, with reported sensitivities ranging from 70% to 90% in detecting hypocalcemia within the first 24 to 72 hours post-surgery [7,8]. Previous research has suggested various PTH threshold values to predict hypocalcemia, with some studies recommending a cutoff of 10-15 pg/mL for identifying high-risk patients [9,10]. However, variability in laboratory techniques, patient populations, and surgical approaches necessitates further validation of these cutoff values in different clinical settings. Moreover, while PTH measurement is beneficial, some studies argue that serial calcium monitoring alone may suffice in routine practice, making it essential to compare both approaches [11]. In Bangladesh, data on the correlation between immediate postoperative PTH levels and subsequent serum calcium changes are limited. Given the increasing number of thyroidectomy procedures performed in the region, there is a pressing need to establish evidence-based guidelines for post-thyroidectomy calcium management. This study aims to assess the impact of immediate postoperative PTH levels on subsequent serum calcium changes in patients undergoing total thyroidectomy. By analyzing the predictive value of PTH, this research seeks to contribute to improved postoperative care, reduce hypocalcemia-related complications, and optimize resource utilization in hospital settings.

METHOGOLOGY

This cross-sectional study was conducted at the General Surgery and Otolaryngology Department of Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, from January 2022 to December 2023. A total of 103 patients who underwent total thyroidectomy were enrolled based on predefined inclusion and exclusion criteria. Patients with a history of prior neck surgery, preoperative calcium or vitamin D supplementation, underlying parathyroid disorders, or renal impairment were excluded. Purposive sampling was used for patient selection. Preoperative routine clinical assessment and laboratory investigations, including serum calcium and parathyroid hormone (PTH) levels, were conducted. PTH was measured using a chemiluminescent immunometric assay, with reference values of 14-74 pg/mL. Serum calcium was assessed preoperatively, immediately postoperatively, and at 24, 48, and 72 hours after surgery using a colorimetric assay. Blood samples were centrifuged, and serum was stored at -40°C before analysis. Postoperative hypocalcemia was monitored clinically and biochemically. Statistical analysis was performed using SPSS version 22.0. Pearson's correlation was used to assess relationships between PTH and serum calcium. A receiver operating characteristic (ROC) curve was constructed to determine the predictive value of immediate postoperative PTH for hypocalcemia.

RESULT

The study included 103 patients who underwent total thyroidectomy. The mean age of the patients was 41.72 ±12.12 years, with a range from 7 to 80 years. The majority of the patients were female, comprising 76.7% of the study population, while males accounted for 23.3%. Regarding the preoperative diagnosis, 70.87% of the patients had multinodular goiter, followed by 22.33% with papillary carcinoma, 2.91% with follicular lesion, 0.97% with medullary carcinoma, and 2.91% with other diagnoses. Preoperative serum calcium levels were within the normal range in 99.03% of patients, with a mean calcium level of 8.87±0.56 mg/dL. The immediate postoperative period showed a decline in PTH levels compared to preoperative values. The mean preoperative PTH was 45.41±15.56 pg/mL, which dropped to 37.63±20.22 pg/mL immediately after surgery, showing a statistically significant reduction ($p=0.001$). This trend persisted at 24 hours postoperatively, with a mean PTH level of 38.27±18.71 pg/mL, and at 48 hours postoperatively, with a mean PTH level of 41.41±17.6 pg/mL. In the immediate postoperative period, serum calcium levels also declined. Among the study population, 20.39% had low serum calcium levels (<8 mg/dL), while 78.64% had normal levels (8-10 mg/dL), and 0.97% had high levels (>10 mg/dL). The mean serum calcium level in the immediate postoperative period was 8.47±1.193 mg/dL, with a range from 2.1 to 10.6 mg/dL. A significant correlation was found between immediate postoperative PTH and serum calcium levels ($r=0.310$, $p=0.001$), suggesting that lower PTH levels were associated with a greater risk of hypocalcemia. Additionally, when comparing features of hypocalcemia with immediate postoperative PTH levels, all 11 patients who developed hypocalcemia had a PTH level below 14 pg/mL, indicating a strong association.

The mean PTH level among hypocalcemic patients was 8.10±4.80 pg/mL, while in normocalcemic patients, it was 40.12±20.36 pg/mL (p=0.001). A receiver operating characteristic (ROC) curve analysis was performed to determine the cutoff value of PTH in the immediate postoperative period for predicting hypocalcemia. The cutoff value was identified as ≤14.4 pg/mL, with a sensitivity of 94.6% and specificity of 100%. The area under the ROC curve was 0.987 (p=0.001), indicating a highly accurate predictive ability.

Table 1: Distribution of the study populations by age

Age (in years)	n	%
≤30 yrs.	24	23.3%
31-40 yrs.	25	24.3%
41-50 yrs.	38	36.9%
51-60 yrs.	10	9.7%
61-70 yrs.	5	4.8%
>70 yrs.	1	0.97%
Mean ±SD	41.72 ±12.12	

Table 2: Distribution of the study populations by pre-operative diagnosis

Pre-operative diagnosis	n	%
Multinodular goiter	73	70.8%
Papillary CA	23	22.3%
Follicular lesion	3	2.9%
Medullary CA	1	0.97%
Others	3	2.91%

Table 3: Comparison of PTH levels between pre-operative and post-operative phases

PTH Level	Pre-Operative	Immediate post-Operative	p-value
Mean ±SD	45.41±15.56	37.63±20.22	0.001s
PTH Level	Pre-Operative	24 Hours After Thyroidectomy	p-Value
Mean ±SD	45.41±15.56	38.27±18.71	0.001s
PTH Level	Pre-Operative	48 Hours After Thyroidectomy	p-Value
Mean ±SD	45.41±15.56	41.41±17.6	0.001s

Table 4: Distribution of the study populations by immediate post-operative serum calcium levels

Serum calcium (mg/dL)	n	%
Low (<8)	21	20.4%
Normal (8-10)	81	78.6%
High (>10)	1	0.97%
Mean ±SD	8.47 ±1.193	

Table 5: Comparison between features of hypocalcemia and PTH levels in the immediate post-operative period

PTH within 1 hour of operation	Hypocalcemia (n=11)		Normal (n=92)		p-value
	n	%	n	%	
Low (<14)	11	100	6	6.5%	0.001s
Normal (14-74)	0	0	78	84.8%	
High (>74)	0	0	8	8.7%	
Mean ±SD	8.10±4.80		40.12±20.36		

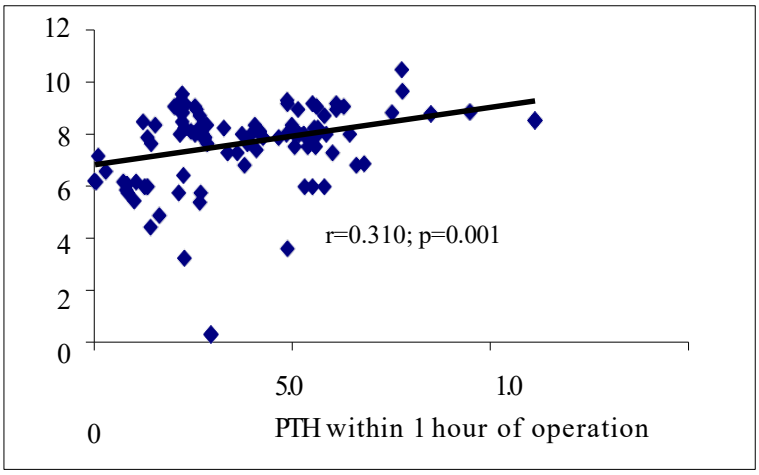

Figure 1: Scatter diagram showing a positive significant correlation (r=0.310; p=0.001) between PTH and serum calcium in the immediate post-operative period

Table 6: ROC curve analysis of PTH in the immediate post-operative period for predicting hypocalcemia

Cutoff Value	Sensitivity (%)	Specificity (%)	Area Under ROC Curve	p-Value	95% CI (Lower-Upper)
≤14.4	94.6	100	0.987	0.001s	0.952 - 1.000

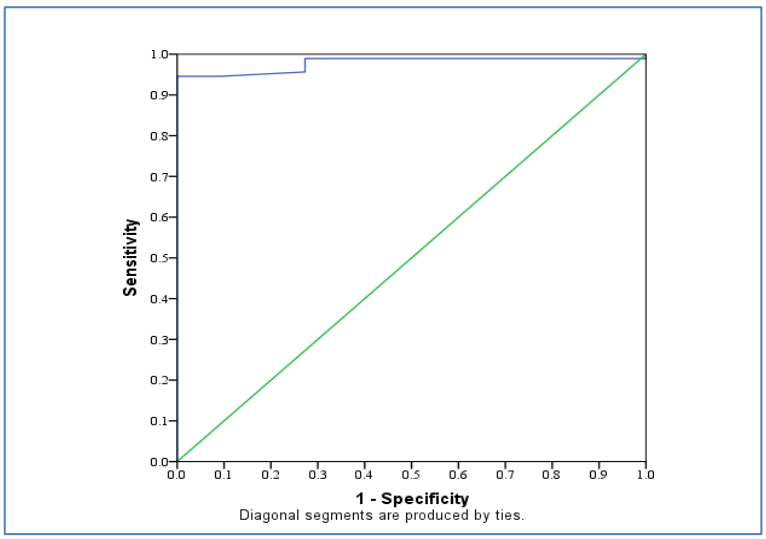

Figure 2: Receiver-operating characteristic (ROC) curve of PTH in the immediate post operative period to predict post operative hypocalcemia

DISCUSSION

The findings of this study indicate that postoperative hypocalcemia remains a significant concern following total thyroidectomy. Our study found that 20.39% of patients developed hypocalcemia in the immediate postoperative period, which aligns with previous research reporting rates ranging from 20% to 30% [12,13]. The primary mechanism underlying this condition is hypothesized to be intraoperative trauma or devascularization of the parathyroid glands, leading to a transient decline in PTH secretion [14]. A significant reduction in PTH levels was observed postoperatively, with the lowest mean level recorded immediately after surgery. This decline is consistent with prior studies that have demonstrated a strong correlation between early postoperative PTH levels and subsequent hypocalcemia [15,16]. Specifically, our study established a cutoff PTH level of ≤14.4 pg/mL as a predictor of hypocalcemia, with high sensitivity and specificity. This threshold is comparable to the values reported by previous studies, where cutoff values typically range from 10 to 15 pg/mL [17,18]. The strong correlation between immediate postoperative PTH and calcium levels (r=0.310, p=0.001) underscores the clinical utility of PTH as a predictive biomarker. Early identification of at-risk patients allows for preemptive calcium supplementation, potentially reducing the incidence and severity of symptomatic hypocalcemia [19]. Some studies advocate for routine postoperative calcium and vitamin D supplementation in patients with PTH levels below the critical threshold [20]. Our study also observed that all patients who developed hypocalcemia had a PTH level

below 14 pg/mL, reinforcing its predictive value. This finding is consistent with previous research suggesting that PTH levels within the first few hours postoperatively can accurately predict hypocalcemia risk and guide clinical management [21,22]. Despite the strengths of this study, including a well-defined cohort and robust statistical analysis, certain limitations should be acknowledged. First, the study was conducted in a single institution, which may limit the generalizability of the findings. Additionally, long-term follow-up data on persistent hypocalcemia were not available, which could provide further insights into the recovery trajectory of parathyroid function. In conclusion, this study highlights the significance of early postoperative PTH assessment in predicting hypocalcemia following total thyroidectomy. Establishing a PTH threshold of ≤14.4 pg/mL may facilitate early intervention, improving patient outcomes. Future studies with larger sample sizes and multicenter participation are warranted to validate these findings and further refine hypocalcemia prevention strategies.

Limitations:
This study was conducted in a single institution, which may limit the generalizability of the findings. Additionally, long-term follow-up data on persistent hypocalcemia were not available. A larger multicenter study with extended follow-up would provide more comprehensive insights into post-thyroidectomy hypocalcemia risk and management strategies.

CONCLUSION

Early postoperative PTH assessment serves as a reliable and effective predictor of hypocalcemia following total thyroidectomy. A PTH threshold of ≤14.4 pg/mL has been shown to have high sensitivity and specificity, making it an excellent marker for identifying patients at risk of developing hypocalcemia. Prompt intervention with calcium supplementation based on PTH levels can significantly reduce the risk of postoperative complications such as tetany or seizures, ultimately improving overall patient outcomes, enhancing recovery, and optimizing long-term management strategies.

Recommendation:
It is recommended to incorporate early postoperative PTH measurement as a routine practice following total thyroidectomy. A PTH level of ≤14.4 pg/mL should trigger timely calcium supplementation to prevent hypocalcemia-related complications, thereby improving patient outcomes and enhancing postoperative care management.

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