ISSN: 2457-0400

Impact Factor: 6.711

WORLD JOURNAL OF ADVANCE HEALTHCARE RESEARCH

www.wjahr.com

Volume: 10, Issue: 1

Page N. 15-22

Year: 2026

Original Article

Coden USA: WJAMA3

PARATHYROID HORMONE AFTER THYROIDECTOMY AS A PREDICTOR OF POST-OPERATIVE HYPOCALCEMIA

[*1]Zinah Faisal Ghazi, [2]Hayder Sabah Al Kawaz

[1]Al-Rusafa Health Directorate, Baghdad, Iraq.
[2]Baghdad- Al-Karkh Health Directorate, Baghdad, Iraq.

Article Received: 16 November 2025 **Article Revised:** 05 December 2025 **Article Published:** 01 January 2026

***Corresponding Author: Zinah Faisal Ghazi**

Al-Rusafa Health Directorate, Baghdad, Iraq. **DOI:** https://doi.org/10.5281/zenodo.18104866

How to cite this Article: *1Zinah Faisal Ghazi, 2Hayder Sabah Al Kawaz (2026). Parathyroid Hormone After Thyroidectomy As A Predictor Of Post-Operative Hypocalcemia. World Journal of Advance Healthcare Research, 9(12), 15–22.

ABSTRACT

Background: Hypocalcemia is a frequent electrolyte abnormality encountered in surgical and medical practice. It can become life-threatening if unrecognized, particularly following thyroidectomy, where it contributes to prolonged hospitalization and increased readmission rates. Early identification of patients at risk is therefore essential. Recent evidence suggests that postoperative parathyroid hormone (PTH) levels may serve as a reliable predictor of subsequent hypocalcemia. **Aim:** To evaluate postoperative PTH levels as a predictor of hypocalcemia following thyroidectomy. **Patients and Methods:** A cross-sectional study with a prospective component was conducted over one year in the surgical department of Al-Yarmouk Teaching Hospital. Ninety-six patients scheduled for thyroid surgery and meeting eligibility criteria were included. Serum calcium and PTH levels were measured preoperatively and at 3, 24, and 48 hours postoperatively, in addition to a follow-up assessment at 10 days. A p-value ≤ 0.05 was considered statistically significant. **Results:** Females represented the majority of participants. The prevalence of hypocalcemia was 21.9% at 3 hours post-surgery. A significant reduction in postoperative calcium and PTH levels was observed compared with baseline, persisting through the 3-, 24-, 48-hour, and 10-day assessments. No significant associations were found between hypocalcemia and demographic or clinical factors including age, gender, ethnicity, residency, disease type or duration, surgical procedure, or number of preserved parathyroid glands. However, calcium levels showed a significant correlation with PTH at all postoperative time points. **Conclusion:** Post-thyroidectomy hypocalcemia is common. Early postoperative PTH levels correlate strongly with calcium decline and may serve as a useful predictor for identifying patients at risk.

KEYWORDS: Hypocalcemia, Parathyroid hormone, Total thyroidectomy.

INTRODUCTION

The thyroid gland is a midline structure situated in the anterior neck and plays a central role in regulating metabolism, growth, and electrolyte balance—particularly calcium homeostasis.[1] Numerous pathological conditions may affect the thyroid, leading to disturbances in hormone secretion and resulting in hypo- or hyperthyroidism.[2] Modern thyroidectomy, however, began in the 19th century with the pioneering work of Theodor Billroth, followed by Sandstrom's identification of the parathyroid glands two decades later.[3] Through the early 20th century, subtotal thyroidectomy was preferred due to concerns that total thyroidectomy carried excessive morbidity, particularly for benign disease.[4] Over time, surgical advancements—including improved hemostasis, recurrent laryngeal nerve protection, and refined techniques to preserve parathyroid glands—have dramatically enhanced thyroidectomy safety.[5] Thyroidectomy is broadly categorized into total and partial procedures, including lobectomy, hemithyroidectomy, and isthmectomy.[6] Historically, subtotal thyroidectomy predominated until 2011, when clinical trends shifted toward total thyroidectomy due to improved outcomes and reduced recurrence rates.[7] However, this shift increased the incidence of postoperative hypoparathyroidism and subsequent hypocalcemia, characterized by low serum calcium, neuromuscular irritability, and biochemical abnormalities such as hyperphosphatemia.[8] Despite subtotal approaches occasionally reducing hypocalcemia

risk, they still carry significant rates of postoperative hypothyroidism, necessitating lifelong monitoring.[9] The parathyroid glands—typically four in number—are located on the posterior surface of the thyroid and are highly variable in position.[10] Their preservation is essential because they maintain calcium homeostasis through the secretion of parathyroid hormone (PTH), which regulates renal calcium reabsorption, vitamin D activation, intestinal calcium uptake, and bone remodeling.[11] The hormone has a short serum half-life, allowing rapid biochemical assessment of parathyroid function[12], while vitamin D status directly influences PTH gene transcription.[13] Therefore, inadvertent removal, devascularization, or injury to parathyroid glands during thyroidectomy may precipitate hypocalcemia, one of the most frequent postoperative complications.[14] Post-thyroidectomy hypocalcemia increases hospital stay, readmission rates, and overall healthcare costs.[15] Although routine calcium supplementation may reduce symptomatic hypocalcemia[16], this approach is considered overtreatment because not all patients require supplementation.[17] Consequently, early postoperative PTH measurement has emerged as a valuable predictor of hypocalcemia. Since its introduction in the early 2000s, PTH monitoring has demonstrated utility in early identification of at-risk patients, timely initiation of therapy, and safe early discharge.[18] However, the optimal timing of PTH assessment remains controversial, with studies evaluating intraoperative and early postoperative measurements at various intervals, yet showing comparable predictive accuracy.[18,19] Aim of the study: to illustrate post-operative Para Thyroid Hormone level as a predictor for hypocalcemia post thyroidectomy.

METHOD

Study Design and Setting: This observational study with a prospective component followed a cohort of patients who underwent thyroidectomy at the Surgical Department of Al-Yarmouk Teaching Hospital, Baghdad, Iraq. The study was conducted over one year, from 1 December 2023 to 31 December 2024.

Sample Size and Eligibility Criteria: All patients admitted for thyroid surgery during the study period were screened for eligibility. A total of 96 patients met the inclusion criteria and were enrolled. Patients were excluded if they had conditions known to alter calcium or parathyroid hormone (PTH) levels, including pre-existing hyperparathyroidism or hypoparathyroidism, chronic kidney disease, significant bone disease, severe vitamin D abnormalities, use of medications affecting calcium metabolism, concurrent parathyroidectomy, pregnancy or lactation, or a history of major neck surgery.

Data Collection Procedures: A structured data sheet was used to collect demographic variables (age, gender, residency, ethnicity), clinical presentation, thyroid diagnosis, duration of illness, and surgical details. Operative notes documented the type of thyroidectomy—total, subtotal, or lobectomy—and the number of parathyroid glands identified. Preoperative serum calcium and PTH levels were assessed, and patients with abnormal baseline values were excluded. Postoperative calcium and PTH measurements were obtained at 3, 24, and 48 hours, and again on postoperative day 10.

Calcium measurements followed laboratory standards (normal 8.5–10.5 mg/dL), using venous sampling without a tourniquet and with patient supine. Hypocalcemia was defined as serum calcium <8.5 mg/dL. PTH was measured using calibrated intact-PTH analyzers with ≤4% margin of error. Hypoparathyroidism was defined as PTH <15 pg/mL.

Surgical Technique and Follow-up: Thyroidectomies were performed under general anesthesia using standard approaches emphasizing meticulous preservation of the recurrent laryngeal nerves and parathyroid glands, supported by a "no-touch" technique and selective ligation of inferior thyroid artery branches. Patients were monitored clinically for Chvostek's and Trousseau's signs and for symptoms of hypocalcemia. Severe cases received calcium gluconate and vitamin D supplementation.

Ethical Considerations and Statistical Analysis: Ethical approval was obtained from the Iraqi Board for Medical Specialization, and verbal informed consent was secured. Data were analyzed using SPSS version 22. Frequencies and percentages summarized categorical variables. McNemar's test assessed changes in calcium and PTH levels over time, while chi-square tests evaluated associations with demographic and clinical factors. A p-value ≤0.05 was considered statistically significant.

RESULTS

Ninety-six patients were included, with females predominating (ratio 19:5). Most participants were from Baghdad (92.7%), and Arabs formed the majority in both genders. All patients had normal preoperative calcium and PTH levels. Duration of thyroid disease was <2 years in 65% of males but ≥2 years in 64.5% of females. Multinodular goiter (MNG) was the most common diagnosis in both genders. Total thyroidectomy was the predominant procedure in males (70%) and females (86.8%). As in table 1.

Table 1: Distribution of the sample by demographical characteristics, Distribution of the sample by pre-operative features.

Demographical Characteristics		Males	Females
		N(%)	N(%)
Age	<20	4(20%)	4(5.3%)
	20-29	2(10%)	18(23.7%)
	30-39	7(35%)	24(31.6%)
	40-49	4(20%)	14(18.4%)
	50-59	2(10%)	10(13.2%)
	≥60	1(5%)	6(7.9%)
Residency	Baghdad	17(85%)	62(81.6%)
	Erbil	1(5%)	6(7.9%)
	Sulaymaniyah	2(10%)	1(1.3%)
	Babil	0	3(3.9%)
	Duhok	0	2(2.6%)
	Kirkuk	0	2(2.6%)
Ethnicity	Arab	17(85%)	61(80.3%)
	Kurds	3(15%)	12(15.8%)
	Turkmen	0	3(3.9%)
Total		**20(100%)**	**76(100%)**

Pre-operative Characteristics		Males	Females	Total
		N(%)	N(%)	N(%)
Duration of the disease	<2 years	13(65%)	27(35.5%)	40(41.7%)
	≥2 years	7(35%)	49(64.5%)	56(58.3%)
Diagnosis	Follicular Ca	1(5%)	1(1.3%)	2(2.1%)
	Graves'	4(20%)	13(17.1%)	17(17.7%)
	MNG	9(45%)	43(56.6%)	52(54.2%)
	PTC	2(10%)	5(6.6%)	7(7.3%)
	Solitary Nodule	2(10%)	9(11.8%)	11(11.5%)
	Thyroiditis	2(10%)	4(5.3%)	6(6.3%)
	Thyroid Cyst	0	1(1.3%)	1(1%)
Surgery	Total	14(70%)	66(86.8%)	80(83.3%)
	Subtotal	4(20%)	8(10.5%)	12(12.5%)
	Lobectomy	2(10%)	2(2.6%)	4(4.2%)
Identified Parathyroid glands	1	11(55%)	19(25%)	30(31.3%)
	2	3(15%)	36(47.4%)	39(40.6%)
	≥3	6(30%)	21(27.6%)	27(28.1%)

Table (2) illustrates the post thyroidectomy symptoms among the studied sample according to gender and follow up points.

Table 2: Post thyroidectomy symptoms and signs according to gender.

Signs and symptoms of hypocalcemia		Males	Females	P value
Post op 3 hours				
	Clinical	0	0	-
	Sub Clinical	0	0	-
Post op 24 hours				
	Perioral numbness	1(25%)	3(75%)	1.000
	Carpopedal spasms	0	2(100%)	
	+ve Chovstek	0	2(100%)	
	Trousseau sign	0	0	
	Sub clinical	1(33.3%)	2(66.7%)	
Post op 48 hours				
	Perioral numbness	1(50%)	1(50%)	1.000
	Carpopedal spasms	0	0	
	+ve Chovstek	0	1(100%)	

	Trousseau sign	0	0	
	Sub clinical	0	0	
Post op 10 days				
	Perioral numbness	0	1(100%)	1.000
	Carpopedal spasms	0	0	
	+ve Chovstek	0	1(100%)	
	Trousseau sign	0	0	
	Sub clinical	0	0	

There was no significant association between age categorizes and levels of calcium and PTH. As seen in table (3) below. Patients who were <20 years of age, had no reduced levels of PTH and Calcium.

Table (3) distribution of the sample according to age by calcium and PTH follow up.

Follow up		**Age in years**						**Total**	**P value**
		<20 N=8	**20-29 N=20**	**30-39 N=31**	**40-49 N=18**	**50-59 N=12**	**≥60 N=7**		
Reduced Calcium (<8.5 mg/dl)	Pre-op	0	0	0	0	0	0	0	1.000
	Post-op 3 hours	0	3(14.3)	4(19)	8(38.1)	3(14.3)	3(14.3)	21(100)	0.142
	Post-op 24 hours	0	1(12.5)	1(12.5)	4(50)	2(25)	0	8(100)	0.183
	Post-op 48 hours	0	0	0	1 (50)	1(50)	0	2(100)	0.445
	Post-op 10 days	0	0	0	1 (50)	1(50)	0	2(100)	0.445
Reduced PTH (<15 pg/dl)	Pre-op	0	0	0	0	0	0	0	1.000
	Post-op 3 hours	0	6(23.1)	8(30.8)	7(26.9)	3(11.5)	2 (7.7)	26(100)	0.495
	Post-op 24 hours	0	4(30.8)	4(30.8)	3(23.1)	2(15.4)	0	13(100)	0.650
	Post-op 48 hours	0	0	0	1 (50)	1(50)	0	2(100)	0.445
	Post-op 10 days	0	0	0	1 (50)	1(50)	0	2(100)	0.445

There was no significant difference between gender and levels of calcium and PTH pre- and post- operatively. As seen in table (4) below.

Table 4: distribution of the sample according to gender place by calcium and PTH follow up.

Follow up		**Gender**		**P value**
		Male N=20	**Female N=76**	
Reduced Calcium (<8.5 mg/dl)	Pre-op	0	0	1.000
	Post-op 3 hours	4(19)	17(81)	1.000
	Post-op 24 hours	2(25)	6(75)	0.670
	Post-op 48 hours	0	2(100)	1.000
	Post-op 10 days	0	2(100)	1.000
Reduced PTH (<15 pg/dl)	Pre-op	0	0	1.000
	Post-op 3 hours	2(7.7)	24(92.3)	0.087
	Post-op 24 hours	0	13(100)	0.064
	Post-op 48 hours	0	2(100)	1.000
	Post-op 10 days	0	2(100)	1.000

Table (4) illustrates the distribution of patients with reduced and normal levels of PTH and calcium according to the type of surgery performed. Although highest percentage of hypocalcemia was reported 3 hours' post-total thyroidectomy yet the association was not significant p value>0.05. There was no significant association between type of surgery and levels of calcium and PTH.

Table 4: distribution of the sample according to type of surgery by calcium and PTH follow up.

Follow up		Type of surgery			P value
		Total N=80	Subtotal N=12	Lobectomy N=4	
Reduced Calcium (<8.5 mg/dl)	Pre-op	0	0	0	1.000
	Post-op 3 hours	17(81)	3(14.3)	1(4.8)	0.947
	Post-op 24 hours	6(75)	1(12.5)	1(12.5)	0.446
	Post-op 48 hours	2(100)	0	0	0.815
	Post-op 10 days	2(100)	0	0	0.815
Reduced PTH (<15 pg/dl)	Pre-op	0	0	0	1.000
	Post-op 3 hours	23(88.5)	2(7.7)	1(3.8)	0.677
	Post-op 24 hours	13(100)	0	0	0.222
	Post-op 48 hours	2(100)	0	0	0.815
	Post-op 10 days	2(100)	0	0	0.815

Table (5) shows the levels of calcium and PTH according to type of diagnosis, no significant difference was reported. Although MNG had the highest number of patients developing reduced levels of calcium and PTH.

Table 5: distribution of the sample according to diagnosis by calcium and PTH follow up.

Follow up		Diagnosis							P value
		Follic Ca N=2	Graves' N=17	MNG N=52	PTC N=7	STN N=11	Thyroiditis N=6	Cyst N=1	
Reduced Calcium (<8.5 mg/dl)	Pre-op	0	0	0	0	0	0	0	1.000
	Post-op 3 hours	0	2(9.5)	16(76.2)	2(9.5)	1(4.8)	0	0	0.305
	Post-op 24	0	2(25)	5(62.5)	0	1(12.5)	0	0	0.934
	Post-op 48	0	0	2(100)	0	0	0	0	0.943
	Post-op 10 days	0	0	2(100)	0	0	0	0	0.943
Reduced PTH (<15 pg/dl)	Pre-op	0	0	0	0	0	0	0	1.000
	Post-op 3 hours	0	3(11.5)	20(76.9)	1(3.8)	2(7.7)	0	0	0.201
	Post-op 24	0	0	12(92.3)	0	1(7.7)	0	0	0.153
	Post-op 48	0	0	2(100)	0	0	0	0	0.943
	Post-op 10 days	0	0	2(100)	0	0	0	0	0.943

STN: Solitary thyroid Nodule

Comparing the levels of calcium and PTH according to the number of parathyroid glands showed no significant association. Table (6) shows the distribution of patients according to level of calcium and PTH by the number of parathyroid glands identified & preserved.

Table 6: distribution of the sample according to number of parathyroid glands by calcium and PTH follow up.

Follow up		The number of parathyroid glands found during surgery			P value
		1.00 N=30	2.00 N=39	≥3.00 N=27	
Reduced Calcium (<8.5 mg/dl)	Pre-op	0	0	0	1.000
	Post-op 3 hours	8(38.1)	7(33.3)	6(28.6)	0.685
	Post-op 24	2(25)	3(37.5)	3(37.5)	0.818
	Post-op 48	0	2(100)	0	0.225
	Post-op 10 days	0	2(100)	0	0.225
Reduced PTH (<15 pg/dl)	Pre-op	0	0	0	1.000
	Post-op 3 hours	9(34.6)	9(34.6)	8(30.8)	0.765
	Post-op 24	3(23.1)	5(38.5)	5(38.5)	0.634
	Post-op 48	0	2(100)	0	0.225
	Post-op 10 days	0	2(100)	0	0.225

No significant difference was reported between levels of calcium and PTH with duration of disease. Table (7) illustrates the distribution of patients by levels of calcium and PTH pre and post operatively, and according to the disease duration.

Table 7: distribution of the sample according to disease duration by calcium and PTH follow up.

Follow up		Duration of the disease		P value
		<2 years N=40	≥2 years N=56	
Reduced Calcium (<8.5 mg/dl)	Pre-op	0	0	1.000
	Post-op 3 hours	10(47.6)	11(52.4)	0.619
	Post-op 24	5(62.5)	3(37.5)	0.271
	Post-op 48	0	2(100)	0.509
	Post-op 10 days	0	2(100)	0.509
Reduced PTH (<15 pg/dl)	Pre-op	0	0	1.000
	Post-op 3 hours	10(38.5)	16(61.5)	0.817
	Post-op 24	2(15.4)	11(84.6)	0.066
	Post-op 48	0	2(100)	0.509
	Post-op 10 days	0	2(100)	0.509

Table (8) illustrates the calcium and PTH levels during the follow up period. The follow up started 3 hours post operatively. The prevalence of hypocalcemia post operatively was 21.9% after 3 hours post-operation, and for PTH was reduced 3 hours post op in 26 patients (27.1%). After 24 hours post operatively, 8 (8.3%) patients had reduced hypocalcemia significantly decreased from post 3 hours (p value <0.001). on the PTH side, the 26 patients with reduced PTH, decreased significantly to only 13 (13.5%) after 24 hours post-op. The McNemar test (also called McNemar's paired chi-squared test) is a non-parametric statistical test used to analyze paired nominal/categorical data when comparing two related groups. It is specifically designed for 2×2 contingency tables where the same subjects are measured twice (e.g., pre-test vs. post-test) or when data is matched (e.g., case-control studies).

Table 8: Distribution of patients by their calcium and PTH levels according to follow- up points. (n=96).

Calcium	Normal	Reduced	P value*
Pre-op	96(100%)	0	
Post-op 3 hours	75(78.1%)	21(21.9%)	0.001
Post-op 24 hours	88(91.7%)	8(8.3%)	0.001
Post-op 48 hours	94(97.9%)	2(2.1%)	0.001
Post-op 10 days	94(97.9%)	2(2.1%)	1.000
PTH	**Normal**	**Reduced**	**P value**
Pre-op	96(100%)	0	
Post-op 3 hours	70(72.9%)	26(27.1%)	0.001
Post-op 24 hours	83(86.5%)	13(13.5%)	0.001
Post-op 48 hours	94(97.9%)	2(2.1%)	0.001
Post-op 10 days	94(97.9%)	2(2.1%)	1.000

*McNemar paired test

Table (9) shows the association of PTH and Calcium levels on each point of follow up. The study showed a significant association between calcium levels and PTH at 3 hours, 24 hours, 48 hours, and 10 days' post operatively.

Table 9: Distribution of the studied sample by PTH and calcium levels one each point of follow-up. (n=96).

		Calcium level		
Post-op 3 hours		Reduced N=21	Normal N=75	P value
PTH	Reduced	18(69.2%)	8(30.8%)	<0.001
	normal	3(4.3%)	67(95.7%)	
Post-op 24 hours		Reduced N=8	Normal N=88	
PTH	Reduced	4(30.8%)	9(69.2%)	0.011
	normal	4(4.8%)	79(95.2%)	
Post-op 48 hours		Reduced N=2	Normal N=94	

PTH	Reduced	2(100%)	0	<0.001
	normal	0	94(100%)	
Post-op 10 days		Reduced	Normal	
		N=2	N=94	
PTH	Reduced	2(100%)	0	<0.001
	normal	0	94(100%)	

DISCUSSION

This study evaluated postoperative PTH and calcium dynamics following thyroidectomy and explored demographic, clinical, and surgical predictors of hypocalcemia. Consistent with global literature, females constituted the majority of thyroidectomy patients (75%), a pattern reported in previous studies from Iraq, Saudi Arabia.[20,21] This gender predominance is well recognized and likely attributable to higher autoimmune susceptibility in women and hormonal influences, particularly estrogen, which affects both thyroid and immune function.[22] The most commonly affected age group in our sample was 30–39 years, in agreement with findings from Basrah, Iraq.[23] Although older age groups showed higher absolute frequencies of hypocalcemia, no statistically significant association was found between age and postoperative calcium or PTH levels. Similar nonsignificant results have been described in studies conducted in Saudi Arabia, Italy, London, and in the meta-analysis by Chen et al.[24] Age-related parathyroid changes may theoretically influence calcium homeostasis[25], yet variations across studies likely reflect differences in sample size, surgical indications, and population characteristics. Some authors have suggested that younger patients may be at higher risk due to more aggressive disease or acute PTH withdrawal[26], but this was not demonstrated in our cohort. Although female patients exhibited more cases of biochemical hypocalcemia than males (17 vs. 4), the association was not statistically significant. Previous studies similarly reported female predisposition to early hypocalcemia but without consistent statistical significance.[27] The possible gender-related anatomical or hormonal explanations remain speculative, and further research is warranted. Parathyroid gland preservation is a key determinant of postoperative calcium balance. In our study, hypocalcemia was more frequent when fewer glands were preserved, although the association did not reach statistical significance. In contrast, Eismontas et al. found gland preservation to be a strong predictor of normocalcemia.[28] This inconsistency may stem from differences in intraoperative identification techniques and surgeon experience. Regarding thyroid pathology, multinodular goiter and papillary carcinoma demonstrated the highest frequencies of hypocalcemia, but without significant association. Similar findings where pathology type did not independently predict hypocalcemia.[29,30] More extensive surgical procedures in malignant cases may explain the trend toward higher hypocalcemia risk.[25] Hypocalcemia prevalence in our study (21.7% at 3 hours) aligns with findings from Germany (22.8%) and Baghdad (24%)[31,32], though lower than reports from Italy, Lithuania, and Saudi Arabia.[20,28] These variations highlight the impact of surgical expertise, parathyroid preservation strategies, and postoperative supplementation protocols.[21] A key finding was the significant decline in calcium and PTH at all postoperative time points, with strong correlations between both markers. studies demonstrated early PTH as a reliable predictor of hypocalcemia.[28,30] Our results reinforce the clinical utility of early PTH measurement in guiding calcium replacement and safely expediting postoperative discharge.

CONCLUSION

The study concluded that hypocalcemia more in post total thyroidectomies. Parathyroid hormone was associated significantly with decreased calcium levels, and can be used as a predictor for hypocalcemia and for prognosis.

REFERENCES

1. Fitzpatrick TH, Siccardi MA. Anatomy, Head and Neck: Adam's Apple. In: StatPearls. Treasure Island (FL): StatPearls Publishing, 2025.
2. Allen E, Fingeret A. Anatomy, Head and Neck, Thyroid. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2024. Available from: https://www.ncbi.nlm.nih.gov/books/NBK470452/. Accessed 12 Nov 2024.
3. Hannan S. The magnificent seven: a history of modern thyroid surgery. Int J Surg. 2006; 4(3): 187-91.
4. Bobanga I, McHenry C. Treatment of patients with Graves' disease and the appropriate extent of thyroidectomy. Best Pract Res Clin Endocrinol Metab, 2019; 33(4): 101319.
5. Luo X, Kandil E. Advancements in thyroid surgery: enhancing safety and efficacy through technological and clinical innovations. Gland Surg, 2024; 13(1): 1-3.
6. Biello A, Kinberg EC, Menon G, et al. Thyroidectomy. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2024. Available from: https://www.ncbi.nlm.nih.gov/sites/books/NBK563279/. Accessed Feb 2025.
7. Wojtczak B, Sępek M, Sutkowski K, Marciniak D, Kaliszewski K. How thyroid surgery has changed in the last 25 years? Research Square, 2024.
8. Hans SK, Levine SN. Hypoparathyroidism. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2025. Available from: https://www.ncbi.nlm.nih.gov/books/NBK441899/. Accessed 5 Feb 2025.

9. Kaplan E, Angelos P, James B, Nagar S, Grogan R, editors. Surgery of the Thyroid. In: Jameson J, De Groot L, de Kretser D, Giudice L, Grossman A, Melmed S, Potts J, Weir G, editors. Endocrinology: Adult and Pediatric. 7th ed. Philadelphia: W.B. Saunders, 2016. p. 1666-1692.e4.
10. Kim S, Shin JH, Hahn SY, Kim H, Kim MK. The parathyroid gland: an overall review of the hidden organ for radiologists. J Korean Soc Radiol, 2024; 85(2): 327-44.
11. Ilahi A, Muco E, Ilahi TB. Anatomy, Head and Neck, Parathyroid. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2023. Available from: https://www.ncbi.nlm.nih.gov/books/NBK537203/. Accessed 5 Mar 2025.
12. Khan M, Jose A, Sharma S. Physiology, Parathyroid Hormone. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2025. Available from: https://www.ncbi.nlm.nih.gov/books/NBK499940/. Accessed 18 Feb 2025.
13. Vasileiadis I, Charitoudis G, Vasileiadis D, Kykalos S, Karatzas T. Clinicopathological characteristics of incidental parathyroidectomy after total thyroidectomy: effect on hypocalcemia. Int J Surg, 2018; 55: 167-74.
14. Schafer AL, Shoback DM. Hypocalcemia: diagnosis and treatment. In: Feingold KR, Anawalt B, Blackman MR, et al, editors. Endotext. South Dartmouth (MA): MDText.com, Inc.; 2000. Available from: https://www.ncbi.nlm.nih.gov/books/NBK279022/. Accessed 12 Nov 2024.
15. Rios-Diaz A, Zheng R, Thibault D, Crispo J, Willis A, Willis A. Understanding nationwide readmissions after thyroid surgery. Surgery, 2019; 165(2): 423-30.
16. Sessa L, De Crea C, Zotta F, Cerviere MP, Gallucci P, Pennestrì F, et al. Post-thyroidectomy hypocalcemia: is routine preferable over selective supplementation? Am J Surg. 2022; 223(6): 1126-31.
17. Muller O, Bauvin P, Bacoeur O, Michailos T, Bertoni MV, Demory C, et al. Machine learning-based algorithm for early prediction of postoperative hypocalcemia after thyroidectomy. Ann Surg, 2024; 280(5): 835-41.
18. Vaiman M, Mizrakli Y, Taha A, Gavriel H. An individual approach to intraoperative parathyroid hormone measurement during total thyroidectomy. Am J Otolaryngol, 2024; 45(2): 104159.
19. Mathur A, Nagarajan N, Kahan S, et al. Association of parathyroid hormone level with post-thyroidectomy hypocalcemia: a systematic review. JAMA Surg, 2018; 153: 69–76.
20. Del Rio P, Rossini M, Montana C, Viani L, Pedrazzi G, Loderer T, Cozzani F. Postoperative hypocalcemia: analysis of factors influencing early hypocalcemia development. Surg, 2019; 18(Suppl 1): 25.
21. Abdullah A. The role of early postoperative parathyroid hormone level after total thyroidectomy in prediction of hypocalcemia. Ann Med Surg, 2021; 65: 102252.
22. Robinson B. Gender Differences in Thyroid Disorder Symptoms: Implications for Treatment Strategies. Thyroid Disorders Ther, 2024; 13.346.
23. Qasim R, Saeed H, Al Abbasi A, Mohammed M. Hypocalcemia following thyroidectomy: a prospective study in Basrah, Iraq. Bas J Surg, 2020; 26(1): 46-50.
24. Chen Z, Zhao Q, Du J, et al. Risk factors for postoperative hypocalcaemia after thyroidectomy: A systematic review and meta-analysis. Journal of International Medical Research, 2021; 49(3).
25. Sharifi A, Rousta FS. Hypocalcemia: Why does this happen after thyroidectomy? EJCMPR, 2023; 2(4): 329-39.
26. Arman S, Vijendren A, Mochloulis G. The incidence of post-thyroidectomy hypocalcaemia: a retrospective single-centre audit. Ann R Coll Surg Engl, 2019; 101: 273-8.
27. Sands N, Cote V, Tamilia M, Hier M, Black M, Payne R. Female gender: a post-thyroidectomy hypocalcemia risk factor. Otolaryngol Head Neck Surg, 2008; 139: P37.
28. Eismontas V, Slepavicius A, Janusonis V, Zeromskas P, Beisa V, Strupas K, et al. Predictors of postoperative hypocalcemia occurring after a total thyroidectomy: results of prospective multicenter study. BMC Surg, 2018; 18(1): 55.
29. Aldhafar A, Alghareeb F, Alammar Z. Clinical study of post-thyroidectomy hypocalcemia. J Endocr Surg, 2023; 23(2): 40-6.
30. Metere A, Biancucci A, Natili A, Intini G, Graves CE. PTH after thyroidectomy as a predictor of postoperative hypocalcemia. Diagnostics (Basel), 2021; 11(9): 1733.
31. Falch C, Hornig J, Senne M, Braun M, Konigsrainer A, Kirschniak A, et al. Factors predicting hypocalcemia after total thyroidectomy: a retrospective cohort analysis. Int J Surg, 2018; 55: 46-50.
32. Surriah MH, Hassan AN, Bakkour AM. Study of hypocalcemia and its risk factors post-thyroidectomy in Al-Karama Teaching Hospital. J Fac Med Baghdad, 2019; 60(4): 185-90.
33. Alqahtani SM, Alatawi AS, Alalawi YS. Post-Thyroidectomy Hypocalcemia: A Single-Center Experience. Cureus, 2021 Nov 29; 13(11): e20006.