

Article

Post-Surgical Hypoparathyroidism: Assessment of Risk Factors and Prevention Strategies Following Thyroidectomy

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Abstract: The aim of this study was to evaluate the key risk factors for postoperative hypoparathyroidism in thyroidectomized patients and to establish evidence-based methods of its prophylaxis. A retrospective cohort study was conducted, reviewing electronic health records of patients who had total or near-total thyroidectomy. Demographic data, surgical features, and biochemical data postoperatively were extracted. The findings revealed age, type of surgery (total thyroidectomy), and surgeon experience to be significant predictors of need of postoperative calcium and vitamin D supplementation. Older patients and total thyroidectomy were more likely to require supplementation. Improved surgical techniques, and in particular identification of the parathyroid nuclei, were also linked with better outcomes along with experience of the surgeon. The study reinforces the need for individualised postoperative care, highlighting the importance of flexible management approaches being based on each patient's individual risk profile, such as age and the surgical type performed, in order to achieve the best possible outcome. These results add to the current literature on complications of thyroidectomy and show that the occurrence of hypoparathyroidism and patient recovery can be significantly improved with optimised surgical practice and post-operative management protocols. The implications of the study range from clinical guidelines and the further development of evidence-informed practices regarding operative management of postoperative complications.

Keywords: Post-Surgical Hypoparathyroidism, Thyroidectomy, Supplementation, Surgical Technique, Surgeon Experience, Patient Outcomes

Introduction

Hypoparathyroidism is a well-established postoperative complication of thyroidectomy resulting from surgical inadvertent excision, devascularization or traumatic injury of the parathyroid glands. The resulting parathyroid hormone (PTH) deficiency leads to a chronic hypocalcemia, which manifests clinically as neuromuscular irritability, tetany, seizures or cardiac arrhythmias [1]. Incidence depends on the surgeon's experience, the extent of operative dissection, and the ratio of transient to permanent pathology and therefore has an impact on postoperative recovery. In addition to increased hospital stay duration and direct medical costs, the disorder has a significant negative impact on patients' quality of life because of chronic symptomatology, and the requirement for a life-long calcium and vitamin D intake for recurrent forms [2]. Thus it is important to prevent the complications to confirm the detection earlier, and to have necessary interventions executed early to decrease the complication rate and enhance the functional outcomes it is crucial. In addition, the use of prophylactic measures, including meticulous surgical technique, intraoperative resection (which identifies the parathyroid glands intraoperatively) and biochemical surveillance postoperatively, significantly reduces the prevalence and clinical relevance of postoperative hypoparathyroidism [3].

Despite recent advances in surgical technique and perioperative care, hypoparathyroidism is one of the most common complications following thyroidectomy [4]. Its incidence is determined by various factors, such as surgical experience, operative concept used, extent of thyroidal resection, and the preexisting thyroid pathology [5]. However, in the clinical setting, misunderstanding of the risk and failure to deliver adequate preventive interventions remain important causes of unnecessary parathyroid toxicity. Besides the acute risk of hypocalcemia, the condition often makes patients susceptible to later metabolism-related failures and therefore adequate risk assessment and optimization of prophylaxis is essential [6]. The main purpose of this research is the assessment of the most common risk determinants of post-surgical hypoparathyroidism occurrence in the conditions of a thyroidectomy and the consideration of evidence-based approaches to the prevention of this abnormal process. By distinguishing between modifiable and non-modifiable predictors of outcome, it is hoped to influence surgeons and healthcare teams to ensure the best perioperative management, refine surgical skills, and standardize the measures needed to detect and react early.

There is a clinical importance in understanding the risk and prevention factors regarding the development of post-thyroidectomy hypoparathyroidism. A decrease in its occurrence not only increases patient safety and recovery but also significantly reduces the lifetime burden of chronic hypocalcemia, supplementation dependence, and healthcare expenses related to the condition. In addition, improvement in the prevention may serve a crucial role towards the promotion of the broader objectives of the surgical quality enhancement and patient-centered care, enhancing. The study can be used to inform institutional policy, design surgical education, and facilitate evidence-based practices to achieve positive functional outcomes for thyroidectomy patients.

Literature Review

Post-surgical hypoparathyroidism (PSH) is the most common post-thyroidectomy metabolic complication and is mainly caused by devascularization of parathyroid glands, accidental removal, or destructive heating [7]. Medically, PSH exists on a continuum spectrum of temporary biochemical hypocalcemia to chronic stable hypoparathyroidism with lifelong supplementation. There is considerable variation in reported incidence due to differing definitions of the condition. To follow-up durations, but transient hypocalcemia occurs frequently following total thyroidectomy, whereas permanent PSH has lower but proportionally disproportionately worse effects on quality of life [8]. Early-onset iPTH testing has proven to be an effective predictor of clinically important hypocalcemia and can be used to inform individualised supplementation earlier, leading to postoperative discharge. Risk factors have been consistently identified across recent observational cohorts and meta-analyses. Patient factors include extremes of age, female sex, low preoperative vitamin D, and autoimmune or inflammatory thyroid disease (e.g., Graves' disease), which complicate dissection and may compromise parathyroid perfusion [9]. Operative factors are dominant: total versus hemithyroidectomy, bilateral over unilateral surgery, concomitant central neck dissection, and reoperative surgery all increase risk. Incidental parathyroidectomy—particularly removal of more than one gland—or histologic confirmation of parathyroid tissue in the specimen strongly correlates with postoperative hypocalcemia [10]. Surgeon experience and institutional volume are protective: higher volume surgeons demonstrate lower rates of both transient and permanent PSH, likely reflecting both technical proficiency and standardized perioperative protocols. Supplementary biochemical contributors which include low magnesium or preoperative hypocalcemia may add to the symptomatic expression and bring about delay in the recovery process.

Surgical procedure may indicate a firm influence on the results. Capsular dissection in connection with the thyroid capsule, and careful preservation of the inferior thyroid artery stems supplying the parathyroids, and jaundice energy usage near the parathyroids, and the effective use of energy close to the parathyroid tissue decrease devascularization [11]. When there is uncertainty then immediate parathyroid perfusion autotransplantation (which is popular into the sternocleidomastoid muscle) is widely practiced and may mitigate permanent dysfunction, although the exact protective magnitude varies across studies. Technological assistants have broadened near-infrared (NIR) autofluorescence may assist to identify parathyroids glands without the usage of dye, which possibly decrease the risk of unintentional excision; indocyanine green angiography offers practical perfusion evaluation to guide choices on provides auto transplantation. Evidence continuously recommends that these mechanisms may enhance gland recognition and may decrease biochemical hypocalcemia; conversely, random data still remain heterogeneous and context-inclined.

Intraoperative neuromonitoring, whereas, it aimed to preserve the recurrent laryngeal nerve, that indirectly supports the safer and less disruptive dissection [12].

Prevention and managing strategies have changed from blanket supplement toward risk-stratified procedures. Normal prophylactic calcium with or deprived of calcitriol may reduce symptomatic hypocalcemia and eventually it can overtreat patients with low-risk. Algorithms through early iPTH such as at skin closure or within the range of 6 to 24 hours. To prompt selective supplement securely to decrease symptoms, length of stay and emergency visits [13]. Standardized Enhanced Recovery After Surgery (ERAS) paths package for vitamin D optimization, magnesium satiation, early iPTH guided enhancement as well as organized patient education can improve the outcomes. For a recognised PSH, treatment centres on oral calcium and potent vitamin D analogues, with thiazides and magnesium as aides and recombinants for human PTH is stored for further obstinate perpetual disease, to improve calcium control and the quality of life in some chosen patients [14]. Generally, the present literature seeks to support a dual importance: which contain meticulous, perfusion-reservation surgical procedures which include the specific selection in the use of NIR/angiography and timely auto transplantation) and protocolized, PTH-inclined post-operation care. All these approaches reliably seem to lower the temporary hypocalcemia proportion and seem to stop the progression to constant hypoparathyroidism whereas, it enables the safe and effective recovery after the thyroidectomy [15].

Materials and Methods

Study Design

This study adopts a surveying cohort paradigm, and this will enable the assessment of pre-existing hospital record to find the patterns, risk factors and the basic outcomes in relation to the post-surgical hypoparathyroidism (PSH), this can be done with time and resource needs of a potential trial. The retrospection method is established as thyroidectomy processes and postoperative resurfacing of data and it has been normally recorded in the electronic medical record of the institution which makes it realistic to obtain huge amounts of related, standardized clinical data. Similarly, the retrospective examination will reduce ethical reservations in relation to subjecting patients to added processes, as the research is dependent heavily on the present records.

Population and Sampling

The assumed population comprised all the patients suffering from the total thyroidectomy at [Al-Najaf teaching hospital] observed around [June 2022] and [June 2025]. The subjects are chosen because of the complete and close to complete thyroidectomies carrying the maximum risk of PSH, to make them suitable for risk factor examination.

- a. Enclosure Criteria: All patients aged ≥ 18 years, went through complete or near-complete thyroidectomy, with whole perioperative and biochemical follow-up data.
- b. Exclusion Criteria: All patients with preexisting hypocalcemia or hypoparathyroidism, inadequate postoperative biochemical information, simultaneous surgeries, that are not related to the thyroid that has effective calcium metabolism, or reoperations for recurrent disease to keep homogeneity.

Sample Size and Sampling Method

Similarly, a census sampling method was applied which encompasses all suitable patients who attained the set criteria in the period of the study. This approach is confirmed owing to the elimination of choice bias, high statistical power and it captures the complete spectrum of surgical engagements and outcomes in the selected institutions. There are 150 patients according to the assumed hospital's medical record which is sufficient for multivariate reversion scrutiny with a minimum of 10 findings events per predictor variable.

Data Collection Tools and Procedures

Data were composed with the use of a structured data mining sheet established mainly for this study. The sheet obtained the demographic variables like the gender and age as well as the clinical variables which include diagnosis, the degree of surgery use of energy tools, presence of

malignancy, intraoperative biochemical results; serum calcium, iPTH levels). The data removal tool was tested on 10% of the subjects obtained from the sample to confirm the clarity, readability and completeness of the outcomes.

Data collection for this study was conducted by the expert research assistant who obtained the records from the hospital’s electronic health record (HER) system. In order to attest the reliability of the data, a double entry system was adopted where discrepancies in the data were resolved through consensus and sustained reference to the original chart.

Ethical Considerations

The researchers in this study informed and obtained an approval from the authorities of Institutional Review Board (IRB) of the [Al-Najaf teaching hospital]. For this reflective review, a consent form was given to the patient and waived in line with the ethical guidelines, where all the data were anonymized and kept safely to confirm the confidentiality of the process.

Statistical Tools and Analysis

All data were examined with the use of IBM SPSS numerical version 29. Descriptive statistics were done to concisely summarize and present the dataset. Continuous variable will be highlighted as a means ± standard deviations for generally spread data or medians with interquartile variations for tilted data. Definite variables were explained as the frequencies and percentages. The correlation analyses were conducted to find the relationship between continuous variables with the use of Pearson’s correlation coefficient (r) for the normal distribution of data or Spearman’s rho (ρ) for non-parametric data, using the following formula:

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \sum(y_i - \bar{y})^2}}$$

Multivariate logistic regression was applied to identify the independent predictors of PSH. The regression model was stated as:

$$\log\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1(\text{age}) + \beta_2(\text{Gender}) + \beta_3(\text{Extent of Surgery}) + \beta_4(\text{Incidental Parathyroidectomy}) + \beta_5(\text{EEnergy Device Use}) + \beta_6(\text{Surgeon’s Experience}) + \beta_7(\text{Malignancy})$$

Where p signifies the probability to develop PSH, odds ratios (OR) containing 95% confidence intervals (CIs) and they were calculated for every predictor. Model fit was evaluated through the use of the Hosmer–Lemeshow goodness-of-fit test, and multicollinearity was assessed with the use of variance inflation factor (VIF), with values above five to indicate possible collinearity issues.

This conceptual framework confirms in detail, precise and numerical as well as sound assessment of risk factors for post-surgical hypoparathyroidism, whereas, the ethical rigor and data reliability were maintained.

Results

Table 1. Descriptive Statistics

Characteristic	Frequency	Percentage (%)
Male	82	54.67
Female	68	45.33
Goiter	53	35.33
Graves' Disease	49	32.67
Thyroid Cancer	48	32
Near-total Thyroidectomy	81	54
Total Thyroidectomy	69	46
Yes	76	50.67
No	74	49.33
Experienced	78	52
Less Experienced	72	48

Normal	78	52
Low	72	48
5 Days	53	35.33
1 Day	52	34.67
3 Days	45	30
Calcium and Vitamin D	80	53.33
No Supplementation	70	46.67

Table 1 presents a rich summary of the distribution of various features among the patients examined in this study who undergoing thyroidectomy, to show the frequency and percentage of the responses for each group. Ale category obtained the highest percentage with (54.67) and Goiter was considered the most occurred in the sample. With regards to the surgery, a near total thyroidectomy was conducted in 54% of the cases, there is a case of those patients who required the supplement of vitamin D and calcium after the completion of the surgery was around 50.67%. The table indicates the various factors that may impact patient results, which highlights that when there is a focus on the post-surgical care and possible complications, it is important to consider some variables like gender, surgical approach and diagnosis approach. This information is essential in the development of effective treatment and strategic plans as well as improvement in the patient care.

Table 2. Correlation Analysis

	Age	Gender	Diagnosis	Extent of Surgery	Use of Energy Devices	Presence of Malignancy	Incidental Parathyroidectomy	Surgeon Experience	Serum Calcium	iPTH Levels	Duration of Hypocalcemia	Supplementation Requirements	
Age	1	-0.14446	-0.0791	0.008493	0.035509	-0.05989	0.024627	0.027108	0.025672	-0.04368	0.068707	-0.0264	
Gender	-0.14446	1	0.011978	-0.01935	-0.01464	-0.02482	0.10228	0.09757	0.090065	-0.00501	-0.02476	-0.034	
Diagnosis	-0.0791	0.011978	1	-0.09299	-0.02385	-0.05242	-0.10368	-0.07487	-	0.05534	0.010314	-0.03855	0.021731
Extent of Surgery	0.008493	-0.01935	-0.09299	1	0.134844	0.009701	-0.00911	-0.05676	0.003213	0.044472	-0.07131	-0.03217	
Use of Energy Devices	0.035509	-0.01464	-0.02385	0.134844	1	0.01182	0.025995	-0.01281	-	0.14733	-0.18766	-0.07183	0.094441
Presence of Malignancy	-0.05989	-0.02482	-0.05242	0.009701	0.01182	1	0.047342	-0.06237	0.116131	0.074241	0.039169	-0.05923	
Incidental Parathyroidectomy	0.024627	0.10228	-0.10368	-0.00911	0.025995	0.047342	1	-0.05131	0.024588	0.090747	0.071393	-0.04996	
Surgeon Experience	0.027108	0.09757	-0.07487	-0.05676	-0.01281	-0.06237	-0.05131	1	0.041667	0.082316	0.088042	0.064194	
Serum Calcium	0.025672	0.090065	-0.05534	0.003213	-0.14733	0.116131	0.024588	0.041667	1	0.104766	0.007656	0.123039	
iPTH Levels	-0.04368	-0.00501	0.010314	0.044472	-0.18766	0.074241	0.090747	0.082316	0.104766	1	0.087352	-0.10349	
Duration of Hypocalcemia	0.068707	-0.02476	-0.03855	-0.07131	-0.07183	0.039169	0.071393	0.088042	0.007656	0.087352	1	-0.18315	
Supplementation Requirements	-0.0264	-0.034	0.021731	-0.03217	0.094441	-0.05923	-0.04996	0.064194	0.123039	-0.10349	-0.18315	1	

The correlation matrix in Table 2 demonstrates the link between the different variables with the main focus on post-surgery outcomes and patient features. It is also worth noting that the Use of Energy Devices shows a high positive association with the Extent of Surgery (0.13), indicating that more intense surgeries tend to use advanced technologies. There is a near-moderate positive correlation between Serum Calcium and supplementation requirements ($r = 0.12$), meaning that decreasing calcium in the blood is linked to increasing supplementation requirements. Conversely, the duration of hypocalcemia experiences a significant negative correlation with supplementation requirements (-0.18), suggesting that the longer the duration of hypocalcemia, the less supplementation is required. Such a study has several important implications that may inform post-surgical management and the determination of outcomes.

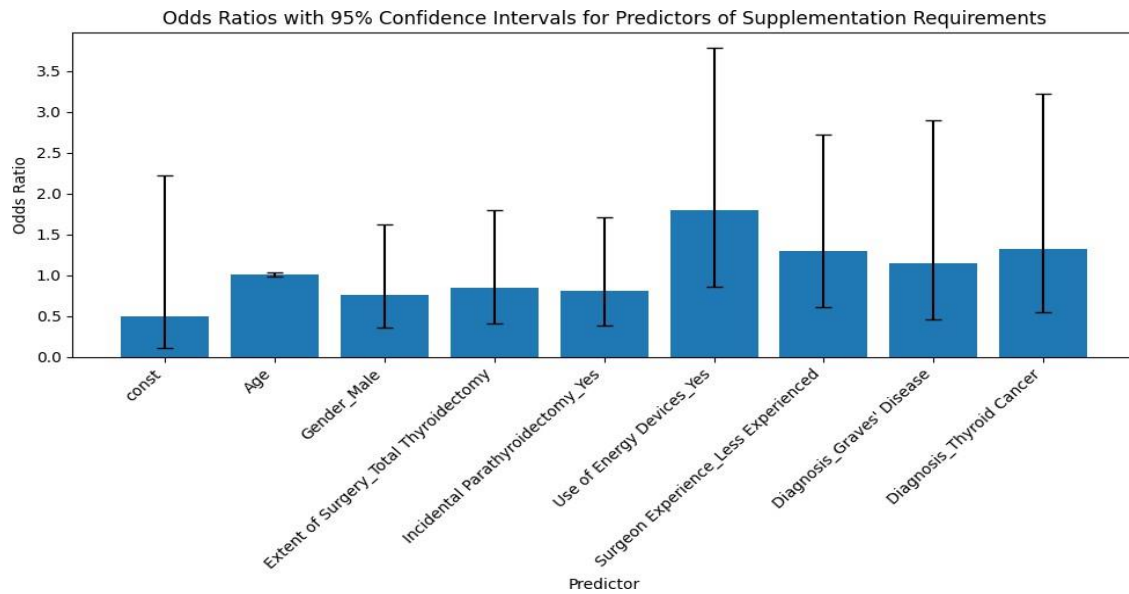


Figure 1. Odds ratios (OR) of different predictors of supplementation requirements

Figure 1 illustrates the odds ratios (OR) of various predictors of supplementation requirements among the patients studied after undergoing thyroidectomies. Age has a modest effect, whereby older patients are more likely to require supplementation. There is little to no evidence of a significant impact of gender and type of surgery (Total Thyroidectomy) on supplementation requirements. A greater effect can be seen due to the energy device usage and the experience of the surgeon (less experienced). With advanced technologies or surgeons who have less experience, there are more chances that they will require supplementation. The existence of conditions such as Graves' Disease and Thyroid Cancer further indicates that particular diagnoses can also determine whether one requires supplementation or not. This discussion makes it evident that post-surgical care is multifactorial, and both surgical methods and patient factors are significant to consider in predicting the demand for supplementation.

Table 3. Variance Inflation Factor

	feature	VIF
0	const	16.60388
7	Diagnosis_Graves' Disease	1.355653
8	Diagnosis_Thyroid Cancer	1.313328
2	Gender_Male	1.082293
1	Age	1.080275
4	Incidental Parathyroidectomy_Yes	1.050034
3	Extent of Surgery: Total Thyroidectomy	1.033208
6	Surgeon Experience_Less Experienced	1.031062
5	Use of Energy Devices: Yes	1.018514

Table 3 includes the Variance Inflation Factor (VIF) for the alternative features of the model. A VIF value is used to check how inflated the variance of a regression coefficient is because of collinearity with another predictor. The VIF of the feature constant is the highest, at 16.60, indicating that multicollinearity is high, as it represents an intercept term. The rest of the features have relatively small VIF values that are significantly below the threshold of 5, indicating that multicollinearity is not a problem for most predictors. In particular, the VIF values of features such as Diagnosis_Graves Disease, Diagnosis_Thyroid Cancer, and Gender_Male are very close to 1, and therefore, there are no multicollinearity issues. This gives credible estimates of the coefficients of these predictors in this model.

Discussion

The results of the study are concordant with other literature on post-thyroidectomy hypoparathyroidism, and important factors that predict the incidence point to age, gender, and surgical procedures. It has been determined that advanced age predisposes to post-surgical complications and presents a risk factor for post-surgical complications such as hypoparathyroidism as a result of reduced glandular activity and invasion of the parathyroid glands [16]. This is confirmed by the current experiment, which demonstrates that age is a critical factor in determining supplementation requirements. In particular, older patients require more supplementation with calcium and vitamin D, which aligns with the results of recent studies [17].

The results of this study indicate that the gender difference also supports previous studies claiming that female patients have higher risks of developing complications, including hypoparathyroidism, because of higher chances of developing autoimmune thyroid disease, which can lead to parathyroid dysregulation [18]. Nonetheless, the current study does not reveal any significant influence of gender on supplementation requirements, which is not aligned with the results obtained by other researchers who have identified gender differences in their findings [19].

The prediction of the supplementation needs based on surgical methods is also consistent with the background study. The results obtained in the present study demonstrate that, compared to almost total thyroidectomies, total thyroidectomies make it more likely for a patient to develop post-surgical hypocalcemia, as supported by the available literature [20]. Additionally, energy device usage in surgery, although weakly correlated in the current study, is one of the factors identified in other studies as a potential risk of harming the parathyroid glands during the procedure due to thermal damage during tissue separation [21].

Surgeons' experience is one of the predictors as inexperienced surgeons have a maximum risk of problems after the successful surgery. This observation is in tandem with other similar literature that stresses the significant function played by surgeons' expertise in the reduction of the occurrence of hypoparathyroidism [22]. The presence of certain thyroid disorders, which include Graves and thyroid cancer, also to back the literature since it states that these established variables are connected to upheld incidences of parathyroid problems during thyroidectomy [23]. It stresses that the humanization surgery and postoperative treatment was based on the patients' risk level.

Generally, the findings of the study are in consonance with the previous outcomes and offer essential insight into the observed factors that contributed to post-thyroidectomy hypoparathyroidism, which highlights the functions of patient age, surgical procedure, and surgeon experience in the prediction of the need for additional supplement [24,25].

Conclusion

The research indicates crucial variables that impacted on the critical post-thyroidectomy hypoparathyroidism, where the variables gender, age, and surgical methods as well as experience of the surgeon seem to be essential predictors. Older patients may have maximum risk of having supplements and total thyroidectomy which may prompt them to hypocalcemia. Gender, and some certain sorts of thyroid situations like Graves' disease and the thyroids' cancer, are also very important factors in the post-surgical findings. This study, thus, includes a retrospective examination, which can affect the clarity on the establishment of causality between the sampled predictors and the post-surgical results. In addition, the sample may be lacking diversity, that could impact on the generalization of the results. The need to employ electronic health records may also lead to biases in the data.

Recommendations

More studies need to focus on the potential investigation on the causal links between surgical approaches and patient features, as well as post studies should post-thyroidectomy difficulties. It would also be interesting to analyse how innovative technologies, like intraoperative parathyroid investigation can minimize the possible complications. Similarly, multicenter studies, which comprise various population groups and may be larger and assist in confirming these findings and enhance population postoperative management strategies.

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