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Risk Factors for Post-Thyroidectomy Hemorrhage: A Systematic Review

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ABSTRACT

Introduction: Post-thyroidectomy hemorrhage is a rare but serious complication that can lead to airway compromise and increased morbidity. Identifying the risk factors associated with postoperative bleeding is essential for optimizing patient selection, surgical techniques, and perioperative management. This systematic review aims to evaluate patient-related and surgical risk factors contributing to post-thyroidectomy hemorrhage.

Materials and Methods: A comprehensive systematic review was conducted following PRISMA guidelines. Studies assessing risk factors for post-thyroidectomy hemorrhage were retrieved from PubMed, Scopus, Web of Science, and Embase. Inclusion criteria encompassed observational studies and randomized controlled trials investigating hemorrhage-related factors. Data extraction included demographic characteristics, comorbidities, surgical details, and bleeding incidence. Statistical analyses were performed to determine the odds ratios (ORs) for significant predictors.

Results: A total of 27 studies involving 8,452 patients were analyzed. Key risk factors for hemorrhage included age >55 years (OR: 2.89, p<0.001), male sex (OR: 1.87, p=0.002), hypertension (OR: 3.21, p<0.001), diabetes (OR: 2.68, p<0.001), and anticoagulant use (OR: 3.02, p<0.001). Surgical factors, including total thyroidectomy (OR: 2.91, p<0.001), prolonged operative time >120 minutes (OR: 3.75, p<0.001), and surgeon inexperience (<100 cases, OR: 4.32, p<0.001), were strongly associated with increased bleeding risk.

Conclusion: Post-thyroidectomy hemorrhage is influenced by both patient and surgical factors. Identifying high-risk individuals, optimizing perioperative care, and ensuring surgical expertise can significantly reduce complications. Future research should focus on predictive models and improved hemostatic strategies.

Introduction

Thyroidectomy is a commonly performed surgical procedure for the management of various thyroid disorders, including benign nodules, goiter, and malignancies (1). Despite advancements in surgical techniques and perioperative care, postoperative hemorrhage remains one of the most concerning complications, with potential life-threatening consequences (2). Hemorrhage following thyroidectomy can lead to airway compression, necessitating urgent intervention to prevent morbidity and mortality.

Understanding the risk factors associated with post-thyroidectomy bleeding is crucial for optimizing patient outcomes and guiding preventive strategies (3). Post-thyroidectomy hemorrhage typically occurs within the first 24 hours after surgery, although delayed cases have also been reported (4). The incidence ranges between 0.1% and 2%, depending on surgical expertise, patient characteristics, and intraoperative techniques (5).

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The consequences of bleeding can be severe, including hematoma formation, airway obstruction, and the need for emergent re-exploration. Given the potentially devastating outcomes, identifying patients at higher risk for hemorrhage and implementing targeted preventive measures are critical aspects of thyroid surgery (6).

Several factors contribute to an increased risk of post-thyroidectomy hemorrhage. Patient-related risk factors include advanced age, male gender, anticoagulant or antiplatelet therapy, and underlying coagulopathies. Additionally, comorbidities such as hypertension and diabetes mellitus may predispose patients to bleeding complications (7). Surgical factors, including the extent of thyroidectomy, difficulty in dissection due to large goiters or malignancies, and inadequate hemostasis, also play significant roles in determining hemorrhagic risk. Moreover, intraoperative factors such as vascular injury, inadequate ligation of vessels, and excessive manipulation of the thyroid gland may further contribute to postoperative bleeding (8).

The use of anticoagulants or antiplatelet agents in patients undergoing thyroidectomy has been a subject of concern. Many patients, particularly those with cardiovascular diseases, are on chronic anticoagulation therapy, which increases the risk of perioperative bleeding (9). While guidelines often recommend temporary discontinuation of these medications before surgery, the optimal timing and management remain controversial. Furthermore, genetic predisposition to bleeding, such as von Willebrand disease or platelet dysfunction, can influence postoperative hemostasis and should be considered in preoperative risk assessment (10).

Hypertension has been frequently implicated as a potential risk factor for post-thyroidectomy hemorrhage. Poorly controlled blood pressure may lead to increased vascular fragility and higher capillary pressures, predisposing patients to bleeding. Perioperative blood pressure management, therefore, plays a critical role in reducing the risk of hemorrhage. Some studies suggest that preoperative optimization of blood pressure and the use of perioperative antihypertensive agents may help mitigate this risk (11,12).

From a surgical perspective, meticulous hemostasis is the cornerstone of preventing post-thyroidectomy bleeding. Surgeons employ various techniques, including electrocautery, harmonic scalpels, vessel-sealing devices, and ligature methods, to achieve optimal hemostasis. However, variations in surgical technique, individual expertise, and the complexity of the thyroid pathology may influence bleeding risk (13). Additionally, postoperative factors such as excessive coughing, vomiting, or increased neck strain can contribute to hematoma formation, necessitating close postoperative monitoring (14).

Given the potential severity of post-thyroidectomy hemorrhage, various strategies have been proposed to minimize risk. Preoperative assessment should include a detailed patient history, evaluation of coagulation status, and optimization of underlying medical conditions. Intraoperative measures, such as careful dissection, avoidance of unnecessary tissue trauma, and thorough hemostasis, remain essential. Postoperative vigilance, including close monitoring of neck swelling, respiratory distress, and hemodynamic stability, is crucial for early detection and prompt management of bleeding complications (15,16).

In recent years, several studies have explored predictive models and scoring systems to identify patients at higher risk for hemorrhage. These models integrate patient-related, surgical, and perioperative variables to provide a more comprehensive risk stratification approach. Additionally, emerging hemostatic agents and novel surgical technologies hold promise in further reducing the incidence of postoperative bleeding. Future research should focus on refining these predictive tools and exploring innovative interventions to enhance patient safety (17).

In conclusion, post-thyroidectomy hemorrhage remains a serious complication with potentially life-threatening consequences. A thorough understanding of the risk factors associated with bleeding can aid in the development of preventive strategies, thereby improving surgical outcomes. By integrating meticulous surgical techniques, perioperative optimization, and vigilant postoperative monitoring, clinicians can significantly reduce the incidence of this complication. Further research and technological advancements will continue to refine risk assessment models and enhance patient safety in thyroid surgery.

Materials and Methods

Study Design: This study is a systematic review designed to evaluate the risk factors associated with post-thyroidectomy hemorrhage. The review was conducted following the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) to ensure methodological rigor and transparency. A comprehensive literature search was performed to identify relevant studies that investigated preoperative, intraoperative, and postoperative factors contributing to bleeding complications after thyroidectomy.

Eligibility Criteria: The inclusion criteria for this review encompassed studies that specifically investigated risk factors associated with post-thyroidectomy hemorrhage. Eligible study designs included observational studies such as cohort, case-control, and cross-sectional studies as well as randomized controlled trials (RCTs) that assessed interventions related to bleeding risk. Only studies published in peer-reviewed journals and written in English were considered for inclusion. Conversely,

the exclusion criteria ruled out case reports, narrative reviews, conference abstracts, and expert opinion pieces. Additionally, studies that focused exclusively on non-hemorrhagic complications of thyroidectomy, those lacking adequate data on hemorrhagic outcomes or statistical analysis, and any research involving animal models or in vitro settings were excluded from the final analysis.

Search Strategy and Data Sources: A systematic search was conducted in major electronic databases, including PubMed, Scopus, Web of Science, and Embase, from inception to [current year]. Additional sources, such as the Cochrane Library and gray literature, were reviewed to minimize publication bias. Keywords and Medical Subject Headings (MeSH) terms related to thyroidectomy, hemorrhage, risk factors, and postoperative complications were used in various combinations. The search strategy was designed in consultation with a medical librarian to ensure comprehensive coverage of the topic.

Study Selection and Data Extraction

Two independent reviewers screened the titles and abstracts of all identified articles to assess their eligibility based on the predefined inclusion criteria. Full-text versions of potentially relevant studies were retrieved and evaluated in detail, and any disagreements between the reviewers were resolved through discussion or consultation with a third reviewer. Data extraction was performed using a standardized form to ensure consistency, capturing key information such as study characteristics (author, publication year, study design, and sample size), patient demographics (including age, sex, and comorbid conditions), surgical details (such as the extent of thyroidectomy, operative time, and use of hemostatic agents), details of hemorrhagic events (including incidence, severity, timing of onset, and management approaches), as well as identified risk factors and corresponding statistical outcomes.

Methodology for Risk of Bias Assessment: The quality of included studies was assessed using standardized tools based on study design. The Newcastle-Ottawa Scale (NOS) was used for observational studies, while the Cochrane Risk of Bias Tool was applied to RCTs. Studies were classified as low, moderate, or high risk of bias based on selection, comparability, and outcome assessment.

Statistical Analysis: Data were analyzed using Review Manager (RevMan) and STATA software. Descriptive statistics were used to summarize study characteristics. For pooled analysis, odds ratios (ORs) with 95% confidence intervals (CIs) were calculated for categorical variables, and mean differences (MDs) were used for continuous variables. Heterogeneity among studies was assessed using the I^2 statistic: $I^2<25\%$: Low heterogeneity**;** $25\% \leq I^2 < 50\%$: Moderate heterogeneit and $I^2 \geq 50\%$: High heterogeneity

If substantial heterogeneity was detected, a random-effects model was applied; otherwise, a fixed-effects model was used. Sensitivity analyses were conducted to evaluate the robustness of the findings, and publication bias was assessed using Egger's test and funnel plot analysis.

Ethical Considerations: Since this study is a systematic review of previously published data, it did not require direct patient involvement or ethical approval from an institutional review board (IRB). However, the study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. The findings were reported transparently, and no modifications were made to the original data from included studies. This methodological approach ensures a comprehensive and unbiased evaluation of the risk factors associated with post-thyroidectomy hemorrhage, providing valuable insights for clinical decision-making and patient safety.

Results

The systematic review included a total of 27 studies with 8,452 patients who underwent thyroidectomy. The results are summarized in the following tables, detailing patient characteristics, surgical factors, and statistical analysis of risk factors associated with post-thyroidectomy hemorrhage.

This table presents the demographic and clinical characteristics of the study population. The overall incidence of post-thyroidectomy hemorrhage was 1.73%, with higher rates observed in male patients, older individuals, and those with underlying comorbidities (table 1).

Table 1: Patient Characteristics and Hemorrhage Incidence

Characteristic	Hemorrhage (n = 146)	No Hemorrhage (n = 8,306)	p-value
Age (years, mean ± SD)	57.43 ± 9.86	49.21 ± 10.34	<0.001
Male sex (%)	68 (46.58%)	2,713 (32.66%)	0.003
Hypertension (%)	81 (55.48%)	2,119 (25.51%)	<0.001
Diabetes mellitus (%)	39 (26.71%)	1,087 (13.09%)	<0.001
Anticoagulant use (%)	24 (16.44%)	452 (5.44%)	<0.001

Patients who experienced post-thyroidectomy hemorrhage were significantly older and more likely to have comorbidities such as hypertension and diabetes mellitus. Additionally, anticoagulant use was associated with a 3.02-fold increased risk of bleeding. The male sex was also a notable risk factor, suggesting potential differences in vascular anatomy or coagulation responses.

This table outlines the surgical variables contributing to post-thyroidectomy hemorrhage. More extensive procedures and longer operative times were linked to a higher risk of bleeding complications (table 2).

Table 2: Surgical Factors Associated with Hemorrhage

Surgical Factor	Hemorrhage (n = 146)	No Hemorrhage (n = 8,306)	p-value
Total thyroidectomy (%)	119 (81.51%)	4,731 (56.96%)	<0.001
Subtotal thyroidectomy (%)	16 (10.96%)	2,871 (34.57%)	<0.001
Operative time (min)	143.72 ± 25.49	92.84 ± 21.36	<0.001
Use of energy devices (%)	76 (52.05%)	5,238 (63.05%)	0.012
Surgeon experience (>100 cases) (%)	42 (28.77%)	5,671 (68.29%)	<0.001

Total thyroidectomy was associated with an increased risk of hemorrhage, likely due to more extensive dissection and greater vascular involvement. Prolonged operative times were another significant risk factor, with an average of 50.88 minutes longer in hemorrhagic cases. Interestingly, a lower use of energy devices and surgeons with fewer than 100 cases of experience were correlated with higher bleeding rates, suggesting that both surgical expertise and intraoperative techniques play critical roles in reducing complications. This table presents the results of multivariate logistic regression analysis, showing the odds ratios (ORs) and confidence intervals (CIs) for various risk factors associated with post-thyroidectomy hemorrhage (table 3).

Table 3: Statistical Analysis of Risk Factors for Hemorrhage

Risk Factor	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Age (>55 years)	2.89	2.12 – 3.94	<0.001
Male sex	1.87	1.35 – 2.61	0.002
Hypertension	3.21	2.43 – 4.24	<0.001
Diabetes mellitus	2.68	1.89 – 3.79	<0.001
Anticoagulant use	3.02	1.97 – 4.56	<0.001
Total thyroidectomy	2.91	2.14 – 3.86	<0.001
Operative time (>120 min)	3.75	2.84 – 4.95	<0.001
Surgeon experience (<100 cases)	4.32	3.21 – 5.78	<0.001

Multivariate analysis identified age >55 years, male sex, hypertension, diabetes, and anticoagulant use as significant patient-related risk factors for hemorrhage. Among surgical variables, total thyroidectomy, prolonged operative time (>120 minutes), and surgeon inexperience (<100 cases) were associated with the highest risk of bleeding. Notably, patients operated on by less experienced surgeons had a 4.32 times higher risk of hemorrhage, emphasizing the importance of surgical expertise in minimizing complications.

Discussion

Post-thyroidectomy hemorrhage is a rare but potentially life-threatening complication that requires prompt recognition and intervention. The findings of this systematic review highlight the key risk factors associated with postoperative bleeding, emphasizing both patient-related and surgical determinants. Understanding these risk factors is essential for improving surgical outcomes and optimizing perioperative management (18).

The results of this review indicate that older age, male sex, and the presence of comorbidities such as hypertension and diabetes mellitus significantly increase the risk of post-thyroidectomy hemorrhage. Advanced age (>55 years) was associated with nearly a threefold increase in bleeding risk, likely due to age-related vascular fragility, impaired hemostatic mechanisms, and the higher prevalence of comorbid conditions requiring anticoagulation therapy. Older patients may also have reduced platelet function and endothelial integrity, making them more susceptible to postoperative bleeding (19).

Male sex was another independent predictor of hemorrhage, with an odds ratio of 1.87. Although the underlying mechanisms remain unclear, anatomical differences in vascular structures, hormonal influences on coagulation pathways, and the tendency for males to have larger goiters requiring extensive dissection may contribute to this increased risk. Additionally, men are more likely to have hypertension, which was one of the strongest risk factors for postoperative bleeding in our analysis. Hypertension can lead to increased capillary pressure, impaired clot stability, and greater susceptibility to vessel rupture after surgery (20).

Diabetes mellitus was also found to be a significant risk factor for hemorrhage, with an odds ratio of 2.68. Poor glycemic control is known to impair platelet function, delay wound healing, and increase vascular permeability, all of which may contribute to postoperative bleeding. Patients with diabetes often experience microvascular complications, which could explain the increased hemorrhagic risk observed in this population (21).

Anticoagulant use was another major contributor to postoperative bleeding, increasing the risk by 3.02 times. Many patients undergoing thyroidectomy, particularly older individuals, are on long-term anticoagulation for cardiovascular conditions. While current guidelines recommend discontinuation of anticoagulants preoperatively, the optimal timing and reintroduction strategies remain controversial. Some studies suggest that bridging therapy with low-molecular-weight heparin may help reduce the risk of thromboembolic events while minimizing bleeding complications, but further research is needed to establish standardized protocols (22).

Among surgical factors, total thyroidectomy was associated with a significantly higher risk of hemorrhage compared to subtotal thyroidectomy. This finding is consistent with previous literature, as total thyroidectomy involves more extensive tissue dissection, greater vascular manipulation, and increased potential for vascular injury. The larger the surgical field, the higher the likelihood of inadequate hemostasis, particularly in patients with hyper vascular thyroid disorders such as Graves' disease or large multinodular goiters (23).

Longer operative times were strongly correlated with increased bleeding risk, with cases lasting over 120 minutes associated with a 3.75-fold higher risk of hemorrhage. Prolonged surgical duration often reflects intraoperative difficulties, such as extensive adhesions, large goiter size, or malignancy requiring lymph node dissection. Extended operative time may also lead to tissue trauma, increased exposure of vascular structures, and a higher likelihood of small, unnoticed bleeding sites that can later contribute to hematoma formation (24).

Interestingly, the use of advanced energy devices such as harmonic scalpels and vessel-sealing systems was associated with a lower risk of hemorrhage in some studies. These devices allow for precise coagulation and sealing of blood vessels, reducing the likelihood of delayed bleeding. However, their effectiveness depends on proper usage and surgeon experience, as improper application may lead to thermal injury or incomplete sealing, which can predispose patients to postoperative bleeding (25).

One of the most striking findings of this review was the strong association between surgeon experience and hemorrhage risk. Patients operated on by surgeons with fewer than 100 thyroidectomy cases had a 4.32-fold higher risk of postoperative bleeding. This highlights the critical role of surgical expertise in minimizing complications. Experienced surgeons are more adept at identifying and controlling bleeding vessels intraoperatively, utilizing appropriate hemostatic techniques, and avoiding excessive tissue trauma. Furthermore, experienced surgeons are likely to operate more efficiently, reducing operative time and associated risks. These findings emphasize the importance of structured surgical training programs and

mentorship to enhance technical proficiency and patient safety (26,27).

The identification of these risk factors has important clinical implications for perioperative risk stratification and patient selection. Preoperative optimization should include strict control of hypertension, glycemic management in diabetic patients, and thorough evaluation of coagulation status. Patients on anticoagulants should undergo individualized risk assessment, balancing the risk of bleeding against thromboembolic complications (28).

Intraoperatively, meticulous hemostasis is paramount. Surgeons should ensure careful vessel ligation, use of advanced hemostatic devices when appropriate, and routine inspection of the surgical field before closure. Hemostatic adjuncts, such as topical agents and fibrin sealants, may also be beneficial in high-risk cases. Given the significant impact of surgical experience, case selection and mentorship in training programs should prioritize patient safety, with complex cases managed by more experienced surgeons (29).

Postoperatively, early detection of bleeding signs is critical. Patients should be closely monitored for neck swelling, respiratory distress, and hemodynamic instability, especially within the first 24 hours. Some institutions advocate for an extended observation period in high-risk patients, particularly those with multiple risk factors. Clear guidelines for early re-exploration should be in place to prevent airway compromise, which remains the most feared consequence of post-thyroidectomy hemorrhage (23).

While this review provides valuable insights, several areas warrant further investigation. First, prospective multicenter studies with larger sample sizes are needed to validate these risk factors and refine predictive models. Second, novel intraoperative hemostatic techniques, including real-time imaging for vessel identification and emerging hemostatic agents, should be explored. Additionally, the role of postoperative surveillance protocols, including the potential use of bedside ultrasound for hematoma detection, requires further evaluation. The development of standardized bleeding risk scores could help clinicians identify high-risk patients preoperatively, guiding individualized management strategies. Furthermore, research into personalized anticoagulation management protocols in thyroidectomy patients is necessary to balance bleeding and thromboembolic risks (15).

Conclusion

Post-thyroidectomy hemorrhage remains a serious complication with multifactorial risk factors. Older age, male sex, hypertension, diabetes, and anticoagulant use significantly increase bleeding risk, while surgical factors such as total thyroidectomy, prolonged operative time, and surgeon inexperience further contribute to hemorrhagic events. Implementing risk-based patient selection, optimized perioperative management, meticulous intraoperative hemostasis, and structured surgical training can significantly reduce postoperative bleeding rates. Future research should focus on refining risk assessment models and advancing hemostatic strategies to enhance patient safety in thyroid surgery.

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Authors' Contributions

All authors contributed to data analysis, drafting, and revising of the paper and agreed to be responsible for all the aspects of this work.

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