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The impact of coblation and non-coblation techniques on hemorrhage and pain outcomes in tonsillectomy: A meta-analysis

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Review Article

ABSTRACT

Tonsillectomy, a common surgical procedure, carries significant complications, including haemorrhage and postoperative pain, impacting patient morbidity and mortality. This study explores the effectiveness of coblation compared to traditional non-coblation techniques in managing these complications. Coblation, proposed to reduce risks associated with tissue removal, was evaluated through a systematic literature search using databases such as PubMed, Google Scholar, and Cochrane. The selected studies were rigorously analysed based on specific inclusion and exclusion criteria. Results from ten journals included in this review indicate no significant difference in primary haemorrhage outcomes between coblation and non-coblation techniques (odds ratio 1.49; 95% CI: 0.68-3.23; p=0.32), with low heterogeneity (I^2=0%; p=0.81). However, coblation was associated with a statistically significant reduction in secondary haemorrhage (odds ratio 0.66; 95% CI: 0.45-0.95; p=0.03) and postoperative pain (effect size -0.84; 95% CI: -0.94 to -0.74; p < 0.00001). These findings suggest that coblation may be more effective in reducing secondary haemorrhage and postoperative pain compared to non-coblation techniques.

INTRODUCTION

Tonsillectomy is a widely performed surgical procedure across the globe, with its primary indications being the treatment of persistent or recurrent tonsillitis, which causes frequent infections of the tonsils, and the management of obstructive sleep apnoea, a condition where the airway becomes blocked during sleep.[1] Although there are various surgical techniques available for tonsillectomy, post-operative pain, as well as primary and secondary haemorrhage, remain the most common and significant complications following the procedure. These issues continue to pose challenges in patient recovery and can complicate the overall healing process, despite the advancements in surgical methods aimed at reducing these risks.[2] The incidence of post-tonsillectomy bleeding is a critical outcome that influences the choice of surgical technique. Primary bleeding occurs within the first 24 hours post-surgery, while secondary bleeding occurs several days later, often associated with sloughing of the healing tissue. Both forms of bleeding can lead to significant morbidity, requiring hospital readmission and sometimes reoperation.[3] These complications also decrease the quality of life and increase the hospital costs.[4]

The incidence of post-tonsillectomy bleeding varies widely. Research by Tran shows that tonsillectomy haemorrhage is mostly influenced by operative technique, patient's age, and sex.[4] Other studies have also demonstrated that factors such as smoking, gender, and the use of perioperative non-steroidal anti-inflammatory drugs (NSAIDs) are associated with an increased risk of postoperative haemorrhage following tonsillectomy. These variables have been identified as significant contributors to bleeding complications during the recovery period.[5]

The choice of surgical technique in tonsillectomy is crucial in developing countries, where medical resources and access to advanced surgical techniques may be limited. Surgical technique is one of the most controllable and directly influential factors in tonsillectomy-related bleeding. Unlike patient demographics or medication histories, which are predisposing factors, the surgical technique actively dictates tissue handling, thermal exposure, and haemostasis during the procedure, thus significantly affecting outcomes across various healthcare settings.[6]

Coblation tonsillectomy utilises radiofrequency energy to dissolve tissue at low temperatures, aiming to minimise damage to surrounding structures and reduce postoperative pain and bleeding.[7] Recent studies suggest that coblation lowers the odds ratio of post-tonsillectomy bleeding[8] and results in lower visual analogue scale (VAS) pain scores compared to other techniques.[9] However, conflicting evidence exists, with some research indicating that non-coblation method, such as cold dissection or bipolar diathermy, may offer comparable or even superior outcomes in certain aspects, including haemostasis and long-term recovery. The non-coblation method, which includes techniques such as cold dissection and bipolar diathermy, can provide outcomes that are comparable to or in some cases, even superior to Coblation, particularly in specific clinical aspects.[10] For instance, cold dissection, a traditional surgical approach that relies on sharp instrumentation without thermal damage, may result in better preservation of surrounding tissues, reducing postoperative inflammation and promoting faster healing.[11] Meanwhile, bipolar diathermy, which uses controlled electrical current to achieve precise coagulation, is often praised for its excellent haemostatic properties, minimising intraoperative bleeding and enhancing surgical visibility. These advantages can lead to improved long-term recovery, with patients experiencing less pain, lower risk of secondary bleeding, and reduced scar tissue formation compared to some thermal-based methods. Additionally, the lower cost and wider availability of non-coblation instruments make them a practical choice in resource-limited settings.[10-12]

While coblation tonsillectomy shows promise for minimising postoperative complications, the mixed findings necessitate more rigorous studies to ascertain its effectiveness in reducing bleeding risk and pain compared to other techniques. By analysing pooled data from multiple sources, this study aims to compare coblation and non-coblation techniques on haemorrhage and pain in tonsillectomy.

METHODS

Study Selection and Eligibility Criteria

The inclusion criteria for the systematic review were defined to ensure the collection of focused and relevant evidence. Eligible studies were research journals and articles published in English between January 2003 and December 2023 that focused on the effectiveness of coblation versus non-coblation techniques in tonsillectomy. Exclusion criteria included articles that were not freely accessible, as well as review articles, systematic reviews, to ensure the synthesis of original and up-to-date research data. Study selection involved screening titles and abstracts using Covidence software, followed by the removal of duplicates and evaluation of full-text accessibility to confirm eligibility. Two independent reviewers screened the articles, and any disagreements regarding study inclusion were resolved through discussion or consultation with a third reviewer if consensus could not be reached. The screening process was conducted manually to ensure accuracy, although automation tools were used for initial duplicate removal.

Data Collection

The literature search was completed on December 2023, from three databases: PubMed, Google Scholar, and Cochrane. These databases were selected for their comprehensive coverage of medical and health sciences literature. The search strategy was developed using a combination of specific keywords such as "coblation", "cold steel dissection", "bipolar haemostasis", "tonsillectomy", "postoperative pain", and "haemorrhage", ensuring maximum retrieval of relevant studies and their combinations. The inclusion criteria were research journals and articles published in English. The exclusion criteria were articles that were not freely accessible, review articles, and systematic reviews. The journals were screened for titles and abstracts according to the inclusion and exclusion criteria, filtered for duplicates, and checked for free accessibility. After reading the articles, a critical appraisal was carried out.

Data collection involved systematically reading and critically appraising each article. Relevant information was extracted using a standardised process, including study design, population characteristics, interventions, outcomes, and findings. The risk of bias in each study was assessed using the Cochrane Collaboration's tool, evaluating factors such as randomisation, blinding, data completeness, and reporting to determine the reliability of findings.

Bias analysis

The certainty of the evidence was evaluated by considering the quality, consistency, and directness of the findings of the studies, assessing the overall confidence in the evidence for the outcomes of interest. Potential reporting bias was also considered, with an evaluation of how selective reporting might have influenced the results, ensuring the comprehensiveness and objectivity of the synthesised evidence. Assessment of method quality was performed by reviewers according to the Cochrane Collaboration's tool for assessing risk of bias.

Data synthesis and effect measures

The data synthesis utilised quantitative methods with Review Manager 5.0. Heterogeneity among studies was assessed using the Higgins I^2 statistic to determine the appropriateness of a fixed or random effects model for the meta-analysis. Relative risks for postoperative haemorrhage and pain were the primary effect measures, which were chosen to assess the risks associated with each surgical technique. Sensitivity analyses were conducted to evaluate the robustness of the findings.

The relative risk data from each study were analysed with Review Manager 5.0. A p-value of less than 0.05 was considered statistically significant. Heterogeneity among the studies was evaluated using the Higgins I^2 statistic, which measures the proportion of variation across studies due to heterogeneity. If the I^2 value exceeds 50%, indicating substantial heterogeneity, a random-effects model is applied. Conversely, if the I^2 value is 50% or less, suggesting low heterogeneity, a fixed-effects model is used.

RESULTS

The literature search on systematic reviews used the following PRISMA method. The image depicts a PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram, which is used to illustrate the process of selecting studies for inclusion in a systematic review or meta-analysis. The diagram begins with the identification of records from three databases: PubMed, Google Scholar, and Cochrane, with an initial total of 3,623 records. After removing duplicates and records marked as ineligible by automated tools, 811 records were screened. Of these, 56 records were excluded for reasons such as not being research articles, not using a coblation technique, or being meta-analyses. The remaining 25 reports were assessed further, leading to 10 reports being included in the final review. This diagram effectively summarizes the rigorous process of filtering studies to ensure the quality and relevance of the included literature in the review.

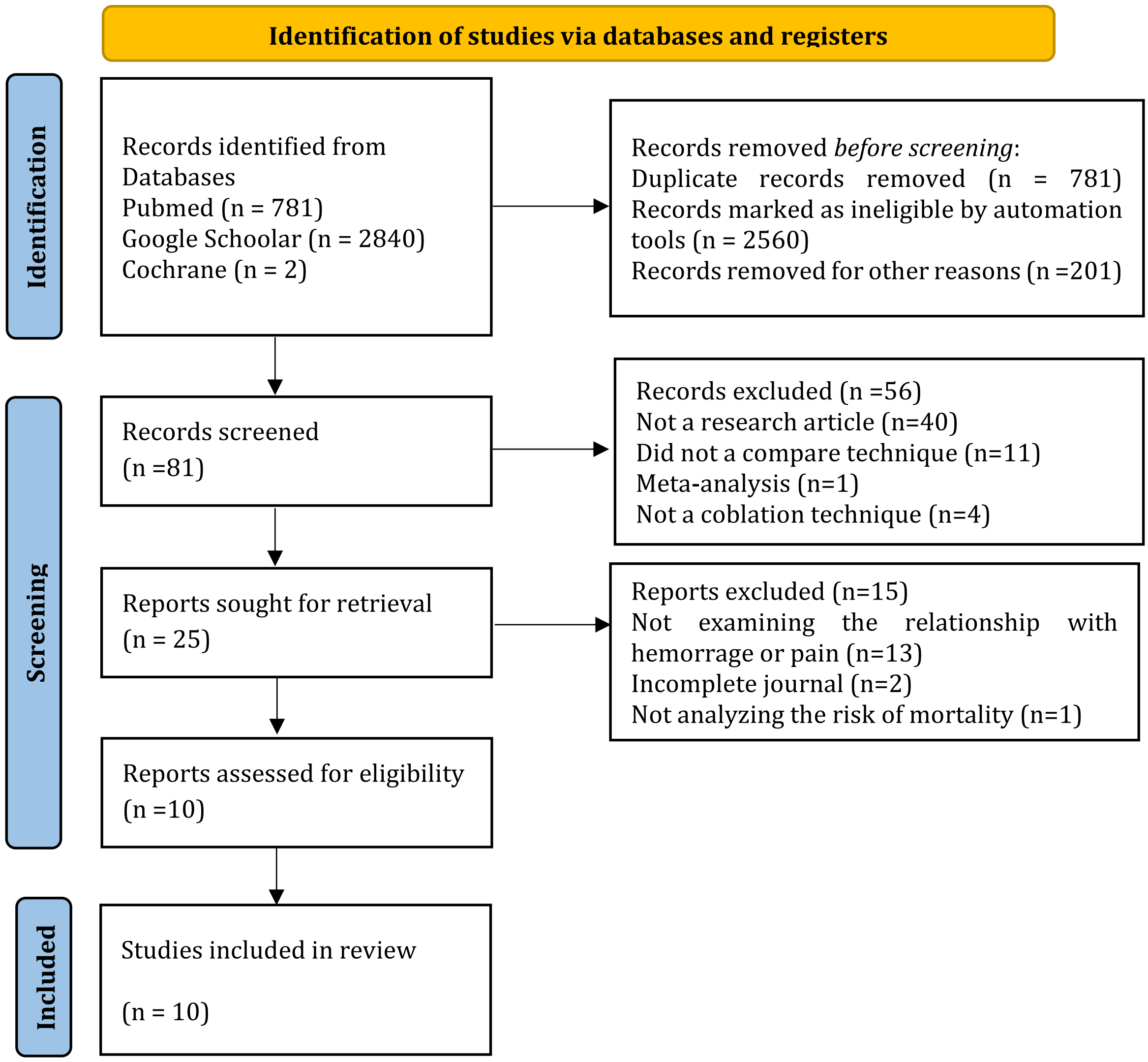

Figure 1. Journal selection flow

Table 1. Bias Analysis

Author	Randomisation (Selection Bias)	Allocation concealment (Selection Bias)	Blinding (Performance Bias)	Incomplete outcome data (Attrition bias)	Selective reporting (Reporting bias)	Quality	Ref
Basu 2019	No	No	No	No	No	Good	9
Belosso 2010	No	No	No	No	No	Good	10
Choi 2022	No	No	No	No	No	Good	13
Ebihavidey 2015	No	No	No	No	No	Good	12
Etteley 2022	No	No	No	No	No	Good	14
Hong 2013	No	Yes	No	No	No	Moderate	15
Jat 2022	No	No	No	No	No	Good	16
Lou 2023	No	No	No	No	No	Good	11
Omrani 2012	No	Yes	No	No	No	Moderate	8
Sheet 2022	No	No	No	No	No	Good	16

Table 1 indicates that the majority of studies reviewed are of "good" quality, suggesting they were generally well-conducted with minimal bias. However, some studies were found to exhibit areas of concern, such as lacking randomisation, allocation concealment, or blinding, which could introduce bias and affect the validity of their findings. Overall, while most studies are reliable, attention should be paid to those with identified biases to interpret their results with caution.

Table 2. Review of journal articles on post-tonsillectomy complications among patients

Author	Population		Age Group	Non-Coblation Method	Complications		
	Coblation	Non-Coblation			Primary Haemorrhage	Secondary Haemorrhage	Postoperative Pain
Basu 2019	64	64	Paediatric	Harmonic Scalpel	No	Yes	Yes
Belosso 2010	844	734	Paediatric and Adult	Dissection Tonsillectomy	Yes	Yes	No
Choi 2022	15	15	Paediatric	Electrocautery	No	No	Yes
Ebihavidey 2015	40	80	Paediatric	Dissection Tonsillectomy and Laser Tonsillectomy	No	No	Yes
Etteley 2022	60	60	Paediatric	Bipolar Electrocautery	No	Yes	Yes
Hong 2013	40	40	Adult	Electrocautery	Yes	Yes	No
Jat 2022	35	35	Paediatric	Cold Dissection	No	No	Yes
Lou 2023	326	327	Adult	Modified Monopolar Tonsillectomy	Yes	Yes	Yes
Omrani 2012	47	47	Paediatric	Traditional Tonsillectomy	Yes	Yes	No
Sheet 2022	25	25	Paediatric and Adult	Cold Dissection Tonsillectomy	No	No	Yes

Table 2 presents a comparative analysis of complications in post-tonsillectomy patients, focusing on the outcomes associated with coblation versus various non-coblation methods across different studies. The patient population consisted of both paediatric and adult groups, with the non-coblation methods ranging from harmonic scalpel to electrocautery and dissection tonsillectomy. The primary complications assessed were primary haemorrhage, secondary haemorrhage, and postoperative pain. The data revealed that while some non-coblation methods, such as dissection tonsillectomy, were associated with higher rates of complications, certain approaches, including traditional tonsillectomy and harmonic scalpel, exhibited a tendency to result in fewer complications, particularly in paediatric patients. Overall, the table highlights the variability in postoperative outcomes based on the surgical techniques and patient age group.

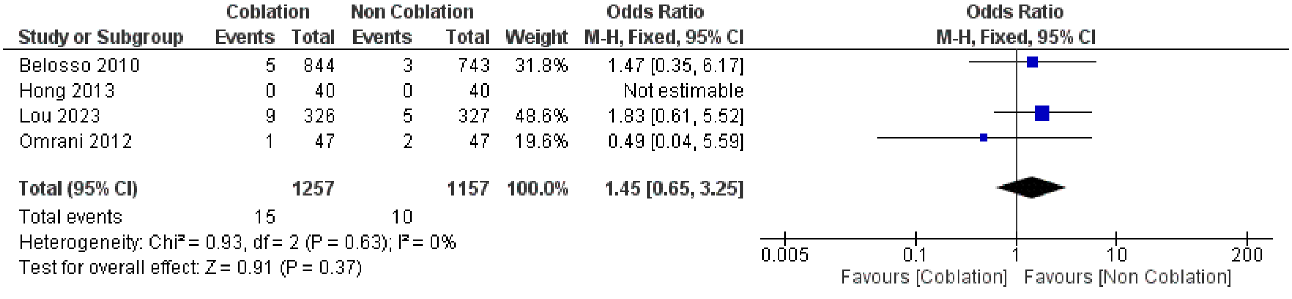

Figure 1. Comparison of the impact of coblation versus non-coblation on primary haemorrhage

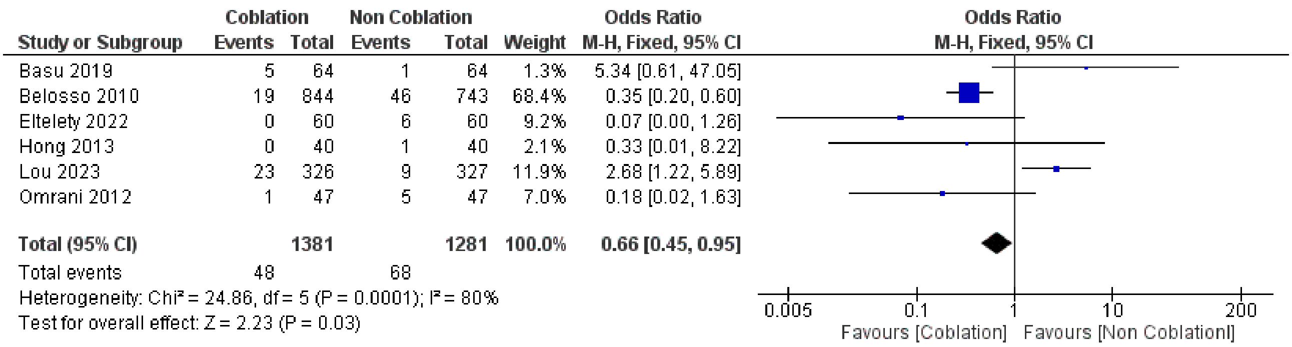

Figure 2. Comparison of the impact of coblation versus non-coblation on secondary haemorrhage

Figure 1 shows the primary haemorrhage outcomes based on the meta-analysis, which compared coblation with non-coblation techniques for managing haemorrhage. The forest plot presented in Figure 1 depicts the odds ratios used to compare the outcomes between coblation and non-coblation groups across four studies. The overall odds ratio was 1.45, with a 95% confidence interval (CI) ranging from 0.65 to 3.25, indicating no statistically significant difference between the groups. The heterogeneity among studies was found to be low, as shown by a Chi^2 value of 0.93, df = 2 (P = 0.63), and I^2 = 0%, suggesting that the results are consistent across studies. The overall Z-test for the combined effect size was not significant either (Z = 0.91, P = 0.37), indicating that there is no clear evidence favouring either coblation or non-coblation based on the data available from these studies. In contrast, Figure 2 examines secondary haemorrhage outcomes, incorporating five studies (Basu 2019, Etteley 2022, Hong 2013, Lou 2023, and Omrani 2012). Here, the meta-analysis revealed a statistically significant reduction in secondary haemorrhage with coblation, with an odds ratio of 0.66 (95% CI: 0.45, 0.95) and a p-value of 0.03, suggesting coblation is more effective for this complication. However, this analysis showed moderate heterogeneity (I^2 = 80%, p = 0.0001), indicating variability across the included studies.

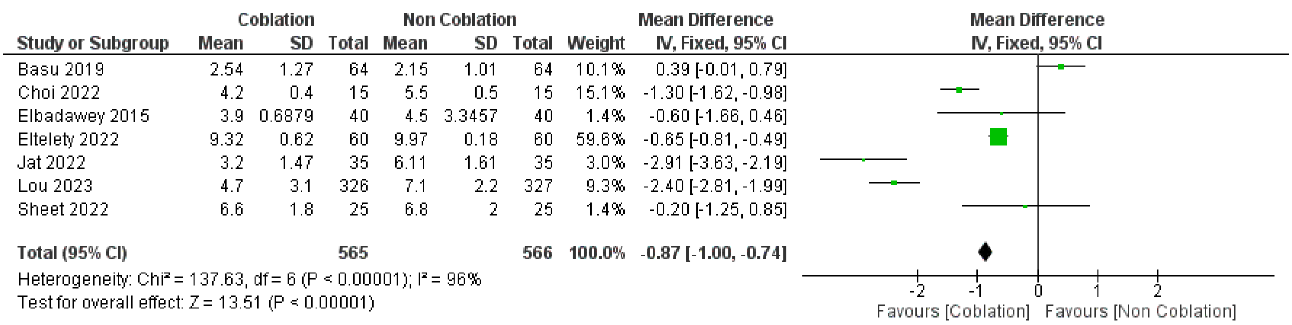

Figure 3. Comparison of the impact of coblation versus non-coblation on post operative pain

Figure 3 summarises the mean differences between coblation and non-coblation groups across seven studies, with outcomes measured in terms of mean difference and 95% confidence intervals (CI). The overall effect indicated a mean difference of -0.87, with a 95% CI ranging from -1.00 to -0.74, favouring the coblation group. Notably, significant heterogeneity was present among the studies (Chi^2 = 137.63, df = 6, P < 0.00001; I^2 = 96%). The overall Z-test for the combined effect size was highly significant (Z = 13.51, P < 0.00001), suggesting that the coblation technique is generally associated with more favourable outcomes compared to non-coblation.

DISCUSSION

This meta-analysis emphasises that while coblation and non-coblation techniques in tonsillectomy are generally safe, coblation offers specific advantages. The results indicate that coblation significantly reduces the risk of postoperative secondary haemorrhage and leads to less postoperative pain compared to non-coblation methods.[17] These findings suggest that coblation may be the better choice for improving patient comfort and minimising complications like bleeding, making it a valuable option in tonsillectomy procedures.[18]

Coblation reduces haemorrhage and postoperative pain by utilising a lower-temperature, controlled plasma field to dissect tissues, which causes less thermal damage to surrounding tissues compared to traditional techniques.[19] This precision minimises the risk of bleeding by sealing blood vessels more effectively during the procedure.[20] Additionally, the reduced thermal injury leads to less tissue trauma, resulting in decreased inflammation and nerve irritation, which are primary contributors to postoperative pain. Consequently, the coblation technique offers a gentler approach that not only reduces the likelihood of haemorrhage but also significantly improves patient comfort by lowering pain levels after surgery.[21] Patients undergoing coblation tonsillectomy typically experience faster wound healing and an earlier return to normal activities. Early research reports shorter recovery periods and reduced analgesic requirements in patients treated with coblation compared to those undergoing traditional tonsillectomy methods.[8] Another study also shows that coblation demonstrates significant advantages in terms of reduced operative time, anesthesia duration, and postoperative care needed.[22]

In addition to these clinical benefits, the ease of use associated with coblation techniques has made it a preferred choice among surgeons, particularly those performing high volumes of tonsillectomy procedures.[23] Coblation devices are equipped with advanced features that allow surgeons to maintain precise control over tissue ablation and coagulation, even in challenging anatomical regions.[24] This enhanced control minimises surgical errors and ensures better patient outcomes. Furthermore, the reduced thermal damage associated with coblation decreases the risk of postoperative infection, as tissue necrosis, which is often a breeding ground for bacterial growth, is less prevalent compared to traditional techniques.[25]

Technological advancements behind coblation techniques are pivotal in reshaping modern tonsillectomy practices.[14] Unlike conventional methods that rely heavily on high-temperature energy sources, coblation operates on a unique principle involving ionised saline to create a plasma field. This plasma field allows for precise tissue ablation at much lower temperatures, typically ranging from 40°C to 70°C, compared to electrocautery or harmonic scalpel techniques that can reach temperatures exceeding 200°C.[26] By working at these lower temperatures, coblation not only minimises thermal damage but also reduces the risk of adjacent tissue necrosis, which is a common complication in high-temperature techniques. The preservation of surrounding tissue integrity is particularly crucial in areas with dense vascular and neural networks, such as the tonsillar bed, where even minor injuries can lead to significant postoperative issues.[27]

Further studies have also explored the molecular impact of coblation on tissue recovery. Reduced thermal injury at the cellular level translates into lower cytokine release, particularly pro-inflammatory cytokines such as tumor necrosis factor (TNF)-alpha and IL-6, which play a major role in amplifying pain and inflammation after surgery.[28] By mitigating this inflammatory cascade, coblation promotes a more controlled and less painful healing process. Additionally, histological analysis of tonsillar tissues post-coblation shows reduced edema and infiltration of inflammatory cells compared to tissues treated with electrocautery or dissection methods. This evidence highlights the biological advantages of coblation and its role in facilitating faster wound healing.[29]

Another noteworthy aspect of coblation is its ability to cater to a diverse patient population.[30] Paediatric patients, for instance, are particularly susceptible to postoperative complications due to their smaller anatomical structures and heightened sensitivity to pain. [7] The gentler approach of coblation reduces the likelihood of severe discomfort and secondary haemorrhage, making it an ideal choice for younger individuals.[7] Similarly, adult patients, who often have more complex medical histories, benefit from the reduced anesthesia and surgical times associated with coblation, lowering the overall procedural risk.[8]

From a patient-centred perspective, coblation's ability to reduce postoperative pain has a profound impact on quality of life. Pain following tonsillectomy is often cited as one of the most challenging aspects for patients, particularly in the paediatric population. Reduced pain means lower dependence on analgesics, which can have side effects such as gastrointestinal discomfort, sedation, and, in rare cases, opioid-related complications.[11] The reduced analgesic requirement not only enhances patient safety but also alleviates concerns for caregivers managing postoperative care. For adult patients, faster recovery times translate into shorter work absences and faster reintegration into daily activities, which are particularly valued in today's fast-paced lifestyle.[12]

Techniques like electrocautery, bipolar electrocautery, and harmonic scalpel involve the use of heat to cut tissue and control bleeding. The heat generated during these procedures can cause collateral thermal damage to surrounding tissues, triggering a stronger inflammatory response, which in turn increases the likelihood of postoperative pain and bleeding. Additionally, the thermal injury can compromise the integrity of blood vessels in the area, making them more prone to bleeding during and after the procedure.[31] Electrocautery is also associated with longer surgical duration, increased use of pain medications, and higher total costs, including operative expenses, physician fees, and post-anesthesia care unit (PACU).[22]

Electrocautery methods, while effective in achieving haemostasis, often compromise tissue integrity due to excessive thermal spread. This collateral damage can extend several millimetres beyond the intended surgical site, resulting in more pronounced inflammatory responses and delayed wound healing. Recent comparative studies have emphasised that the extent of thermal spread correlates with postoperative complications, including dysphagia, odynophagia, and prolonged wound crust formation.[32] Additionally, the risk of secondary haemorrhage is higher in cases where electrocautery is used extensively, as the initial sealing of blood vessels is more susceptible to rupture during the wound healing process.[22]

The harmonic scalpel, though considered an improvement over electrocautery due to its ability to cut and coagulate simultaneously, still operates at high temperatures (150°C to 400°C), which poses similar risks of thermal injury.[9] While the harmonic scalpel reduces operative time and enhances surgical precision, its use in areas with delicate vascular structures, such as the tonsillar fossa, requires careful handling to avoid inadvertent damage. Surgeons often weigh these risks against the benefits, particularly in cases involving complex anatomy or recurrent tonsillitis, where achieving complete resection with minimal trauma is paramount.[34]

On the other hand, techniques such as dissection tonsillectomy, cold dissection, and traditional tonsillectomy rely on mechanical cutting without the use of heat.[33] While these methods avoid thermal injury, they still cause significant mechanical trauma to the tissues, including blood vessels and nerves. This trauma can lead to primary or secondary bleeding and can also exacerbate postoperative pain due to the direct injury to nerve fibres. Moreover, the ability to achieve haemostasis, or the stopping of bleeding, may be less effective with these mechanical methods compared to those using energy-based tools, increasing the risk of postoperative haemorrhage and associated pain. Overall, the extent of tissue trauma and the effectiveness of bleeding control are key factors that contribute to the pain and bleeding observed with this surgical technique.[34]

The limitations of this meta-analysis are notable and include variability in study designs and surgical techniques, which introduces heterogeneity in the results. Variations in patient demographics such as age and health conditions, along with different measurement methods for outcomes such as haemorrhage and postoperative pain, contribute to inconsistencies. The small sample sizes in some studies may also limit the generalizability of the findings. There is potential for publication bias due to the reliance on published data, as studies with favourable outcomes are more likely to be published.[35] Additionally, the learning curve associated with newer techniques including coblation, which depends significantly on surgeon experience, may skew the results. These factors suggest that the conclusions drawn from this review should be approached with caution and underscore the need for further high-quality research to validate these findings.[36]

Notwithstanding these limitations, the review has significant strengths that enhance its value. The rigorous application of PRISMA guidelines and the comprehensive search across multiple databases ensure a thorough and robust analysis, providing credible comparisons between coblation and non-coblation techniques.[37] By including a variety of studies, the review effectively demonstrates coblation's efficacy in reducing postoperative complications, particularly secondary haemorrhage and pain, which are critical outcomes in tonsillectomy.[38]

The implications of these findings for developing countries' Sustainable Development Goals (SDGs), particularly SDG 3: Good health and well-being are substantial. By identifying and recommending a surgical technique that minimises complications and enhances postoperative recovery, this research can help improve health outcomes across developing countries. This is especially crucial in rural and underserved areas where healthcare resources are limited.[39] Adopting more effective and safer surgical techniques aligns with developing countries' goals of improving health care quality, reducing healthcare costs, and moving towards universal health coverage, thereby contributing positively to national well-being and sustainable development.[40]

CONCLUSION

Coblation techniques in tonsillectomy offer significant advantages over non-coblation methods, particularly in reducing the risk of postoperative secondary haemorrhage and alleviating postoperative pain. Future research should focus on large-scale, randomised controlled trials to confirm these findings across diverse patient populations and surgical settings. Additionally, exploring the long-term outcomes of coblation versus non-coblation techniques, including the impact on healing time and overall recovery, will be crucial.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REGISTRATION AND PROTOCOL

This review was not registered in any public review protocol databases, such as PROSPERO or INPLASY. However, the methodology followed standard guidelines for narrative and thematic reviews, including systematic search, inclusion/exclusion criteria, and thematic synthesis. All procedures adhered to scientific publication ethics.

ACKNOWLEDGMENTS

The study was conducted and the manuscript was written solely by the authors.

DATA AVAILABILITY STATEMENT

This article is a literature-based review and does not involve primary data collection. All data supporting the findings of this study are available through the cited references. For any additional inquiries, data access requests may be directed to the corresponding author via email.

SUPPLEMENTARY MATERIAL(S)

No supplementary materials are provided with this article. All relevant content is included within the main text and reference list. Should additional files be required, such as data extraction tables or protocol checklists, they will be made available upon reasonable request.

AUTHOR CONTRIBUTIONS

SDK conceptualized the study, designed the review protocol, defined intellectual content, conducted the literature search, and managed data acquisition and analysis. MMRP performed statistical analysis and drafted the manuscript, revising it based on feedback. EI provided critical insights into the conceptual framework, assisted in the literature search, and contributed to data acquisition and analysis. EI was involved in drafting and revising the manuscript and approved the final version.

DECLARATION OF USING AI IN THE WRITING PROCESS

Artificial intelligence tools were employed to correct typographical and grammatical errors in this review article prior to professional proofreading.

LIST OF ABBREVIATIONS

CI: Confidence interval; PRISMA: Preferred reporting items for systematic reviews and meta-analyses, NSAID: Non-steroidal anti-inflammatory drugs, VAS: Visual analogue scale, CI: Confidence interval, TNF: Tumor necrosis factor, IL: Interleukin, PACU: Post-anesthesia care unit, SDG: Sustainable development goals

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