Thermal Welding Tonsillectomy versus Monopolar Electrocautery Tonsillectomy: A Systematic Review and Meta-Analysis of Randomized Clinical Trials

Systematic Review

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Abstract

Objective: In hopes of contributing to the decision about the best surgical option in tonsillectomy, we performed this work to compare the effectiveness of the thermal welding system (TW) and monopolar electrocautery (ME) tonsillectomy in terms of postoperative pain, postoperative bleeding, and operation time in patients undergoing tonsillectomy, to determine which procedure is most expected to enhance the postoperative quality of life.

Methods: Digital databases, including PubMed, Scopus, Cochrane, Web of Science, and Google Scholar, were systematically screened from inception up to October 2022. The included randomized controlled trials (RCTs) were evaluated for risk of bias via the Cochrane tool (version 2). The outcomes were summarized as risk ratio (RR) or mean difference/standardized mean difference (MD/SMD) with a 95% confidence interval (CI) in a random-effects model.

Results: The three RCTs that met our criteria were included in the study. Overall, 151 patients had been enrolled in these three RCTs, in which 75 and 76 were allocated to the TW and ME groups, respectively. The postoperative pain levels were substantially reduced, favoring the TW arm over the ME arm [n=2 RCTs, SMD=-0.39, 95% CI (-0.67, -0.12), p=0.005]. Also, the analysis revealed a substantial variation between the TW and ME arms in terms of operation time [n=2 RCTs, MD=3.29 minutes, 95% CI (1.42, 5.17), p=0.0006]. However, the analysis revealed no substantial variation between the TW and ME arms in term of postoperative bleeding [n=3 RCTs, RR=0.40, 95% CI (0.06, 2.62), p=0.34].

Conclusion: This meta-analysis revealed that postoperative bleeding for tonsillectomy were similar between the ME and TW techniques. However, TW showed lower postoperative pain levels than ME statistically but without achieving significant clinical advantage.

Keywords: Tonsillectomy, thermal welding, monopolar electrocautery, pain, bleeding

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Introduction

In otorhinolaryngology, tonsillectomy is among the most often performed operations (1). Recurrent tonsillar infections and tonsillar hypertrophy are the most prevalent reasons for tonsillectomy procedures because the tonsils act as a septic focus and obstruct the upper airway (2, 3).

In the last decades, with advancements in anesthetic and surgical methods, fatality incidents resulting from tonsillectomy have declined. But still, tonsillectomy is accompanied by severe complications, including pain, hemorrhage, and dietary restrictions (4, 5). New techniques and tools have been introduced to avoid and reduce these comorbidities and complications. The majority of these techniques, such as cold-steel dissection, monopolar electrocautery (ME), bipolar electrocautery (BE), coblation, laser dissection, and thermal welding system (TW) (6-9), work by applying a variety of energy sources to denature the muscles and tissues and block the blood vessels outside of the typical coagulation pathways (10). These approaches have been examined and contrasted in children, adults, and both; nonetheless, TW and ME are currently the most applied approaches (10, 11).

Undertaking a tonsillectomy with TW is an innovative approach. It depends on using temperature, pressure, and time to seal vessels. It depends on applying heat and pressure to block blood vessels. The instrument has a heat source in one arm powered by a low-voltage current set between 300 and 400 degrees Celsius. This heat source is forced against an opposing arm to generate the ideal pressure for tissue fusing and dividing. Additionally, the fusing and dividing process of the tissues is accompanied by evaporation along the constrained area in touch with the heat source (12). The latest research that evaluated the effectiveness of this novel method discovered that TW caused only minimal tissue damage. These investigations presented TW as a secure approach to tonsillectomy procedures. Additionally, they showed that it shortened the operation duration and provided adequate hemostasis during surgery and tissue dissection (13).

ME is among the new techniques used for tonsillectomy. ME abrades structures and tissues around the tonsils by producing an electric discharge between the tissue and the ME. It sections tissues at 400 °C or above. It coagulates vasculature and separates the tissue holding the tonsil to the underneath pharyngeal constrictor muscles by applying high heat to the tonsillar region. Its use is complicated with issues relating to postoperative comorbidities, including thermal damage to adjacent structures. Thermal injury to the pillar mucosal layer might delay healing and aggravate late problems involving postoperative bleeding and pain (14).

Despite the various advantages offered by the current procedures and technologies, there still has to be clarity on the approach and technology that will result in the least amount of postoperative discomfort and the highest level of safety in tonsillectomy (15, 16). In hopes of contributing to the decision about the best surgical option in tonsillectomy, we performed this work to compare the effectiveness and safety of the TW and ME tonsillectomy in terms of postoperative pain, postoperative bleeding, and operation time in patients undergoing for tonsillectomy to determine which procedure is most expected to enhance the postoperative quality of life.

Methods

We adopted the Cochrane Handbook guidelines for Systematic Reviews, besides the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement (17, 18). Ethical approval was exempted since this type of a study is based on published articles.

Eligibility Criteria and Study Selection

We included (i) patients: individuals undergoing tonsillectomy; (ii) intervention: thermal welding technique; (iii) comparison: ME technique; (iv) study outcomes: reporting of one of our specific endpoints (operation time, postoperative pain, and postoperative bleeding); and (v) study design: randomized controlled trials (RCTs). The exclusion criteria comprised: (i) procedures other than tonsillectomy; (ii) procedures other than TW and ME, such as conventional dissection, coblation, and laser; and (iii) studies other than RCTs, such as case reports, observational studies, review articles, and letters.

Information Sources, Search Strategy, and Study Selection

Digital databases, including PubMed, Scopus, Cochrane, Web of Science, and Google Scholar, were systematically screened from inception up to October 2022. Our search strategy comprised: (tonsillectom* or adenotonsillectom* or "tonsil surgery" or "tonsil removal" or "tonsillar surgery" or "tonsillar removal") and ("thermal welding" or thermal or welding or "tissue welding" or "thermal welding system" or "thermal fusion") and (monopolar or unipolar or electrocautery or "unipolar cauterization" or "monopolar cauterization"). To widen our search for relevant studies, we looked through the references of the eligible trials and the recent reviews. The method for choosing the studies involved excluding duplicate citations, title/abstract screening, and full-text examination of the possible resources. In a separate way, two authors completed the search strategy and selected studies; in case of discrepancies, we contacted and consulted the principal investigator.

Quality Assessment of the Included Studies

The Cochrane risk of bias tool (RoB 2) was used to evaluate the quality of each trial (19). Each assessed domain was given a score for bias risk, which ranged from low to some concerns to high. Two co-authors evaluated the quality of the included studies, and for discrepancies, we adopted consultation with the principal investigator.

Data Collection and Study Endpoints

We collected the baseline summary from the included trials and populations, including the author's first name and the publication year (study identifier), country, trial duration, study arms, sample size, type of patients (adult or pediatric), age, gender, and duration of follow-up. Our endpoints included operation time (minutes), postoperative pain score, and postoperative hemorrhage (%). Postoperative pain score was assessed by a 10-point scale (0= no pain, 10= intolerable pain). Furthermore, postoperative bleeding was characterized as primary (in <24 hours) or secondary (in >24 hours). Two co-authors independently collected the data using a predesigned extraction sheet, and discrepancies were settled by consultation with the principal investigator.

Statistical Analysis

The Mantel-Haenszel technique was used to conduct the analyses on dichotomous data, which were pooled as a risk ratio (RR) with a 95% confidence interval (CI). The studies were carried out using the Inverse-Variance method, and continuous data were gathered as mean difference (MD) or standardized mean difference (SMD) with 95% Cl. In every analysis, the random-effects model was applied. For heterogeneity, we adopted the chi-square ($p<0.1$ and I-square >50%) and I-square tests (20). We assessed postoperative pain on days 1, 5, and 10. Concerning postoperative bleeding, we clarified it to primary (in <24 hours) and secondary (in >24 hours). For all endpoints, statistical significance was determined as $p<0.05$. The RevMan software (version 5.4 for Windows) was adopted for statistical analysis. Also, subgroup analysis was performed according to the age group (pediatric and adult).

Results

Summary of the Literature Search

From the literature search, we obtained 393 studies, of which 163 were duplicated studies. Of the remaining 230 citations, 223 studies were omitted during title/abstract screening, and the remaining seven studies continued to full-text screening. Finally, three RCTs were included in our pooled analysis (21-23). Figure 1 summarizes the PRISMA flowchart.

Summary of the Characteristics of the Included Studies and the Participants

Overall, 151 patients were enrolled in these three RCTs, in which 75 and 76 participants were enrolled in the TW and ME arms, respectively. These RCTs were conducted in Turkey, the USA, and Finland. Follow-up duration ranged from ten to 30 days. Table 1 summarizes the baseline demographics of the included RCTs and populations.

Summary of the Quality Assessment

The overall quality assessment was a low risk of bias in one RCT and some concerns of bias in one RCT, and a high risk of bias in one RCT (21-23). One RCT was evaluated as having some concerns of bias for the randomization process domain, as no information was provided about the randomization process and the allocation concealment

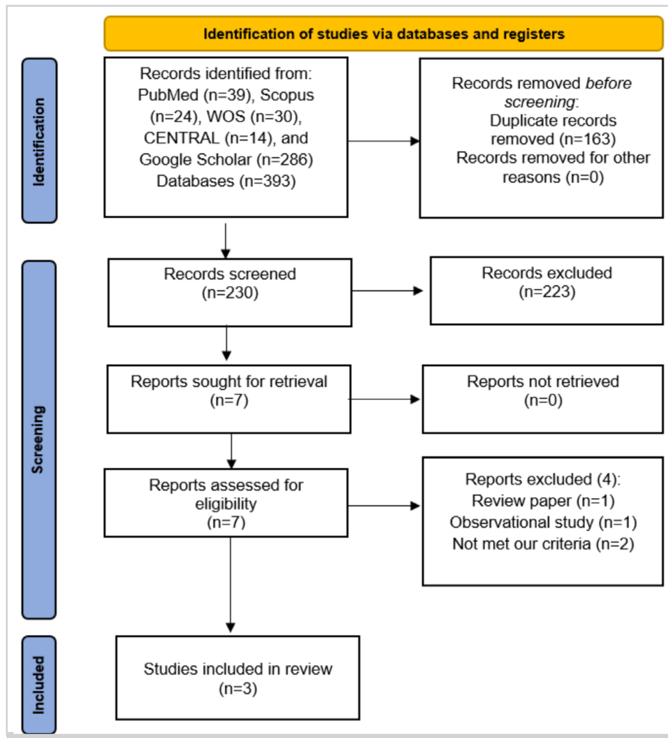

Figure 1. PRISMA flow chart for literature search and study selection

Table 1. Summary of baseline characteristics of the included trials

Study ID	Country	Trial duration	Age group	Trial group	Participants	Age (years) Mean ± SD	Sex, n		Duration of follow-up
							Male	Female	
Cunningham and Chio (21) 2015	USA	N/A	Adults	TW	n=24	18-50 (range)	N/A	N/A	21-30 days
				ME	n=24	18-50 (range)	N/A	N/A	
Dal et al. (22) 2021	Turkey	From December 2017 to December 2018	Pediatrics	TW	n=20	5.3	9	11	10 days
				ME	n=23	5.65	10	13	
Silvola et al. (23) 2011	Finland	N/A	Adults	TW	n=31	26 ±8	14	17	14 days
				ME	n=29	28 ±11	12	17	

N/A: Not available, TW: Thermal welding system, ME: Monopolar electrocautery, SD: Standard deviation method. For the domain of missing outcome data, one RCT was evaluated as having a high risk of bias due to a lack of detailed information about an important outcome, postoperative pain. Additionally, for the domain of the selection of reported results, one RCT was evaluated as having some concerns of bias because there was a lack of evidence to rule out the potential that reported outcome data were chosen from a variety of outcome measurements. Figures 2 and 3 show the RoB graph and summary, respectively.

Meta-Analysis of the Endpoints

A. Operation duration (minutes)

There was a substantial variation between the TW and ME arms regarding mean operation time [n=2 RCTs, MD =3.29 minutes, 95% CI (1.42, 5.17), p=0.0006]. The gathered analyses were heterogeneous (chi-square p<0.1, I-square >50%) (Figure 4).

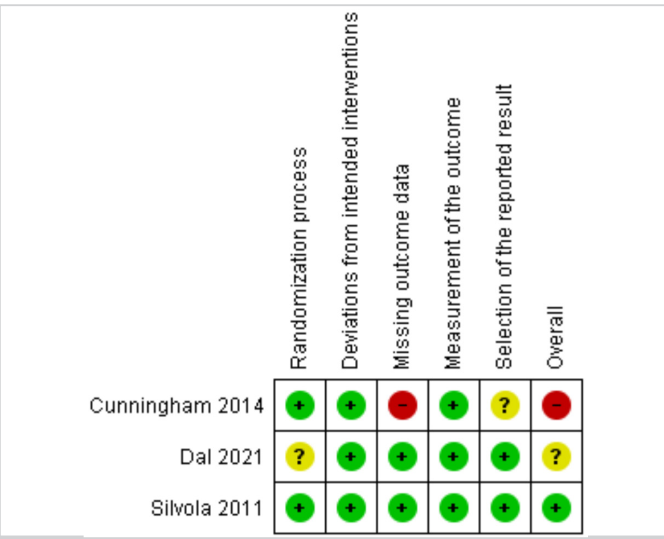

Figure 2. Risk of bias (RoB) graph

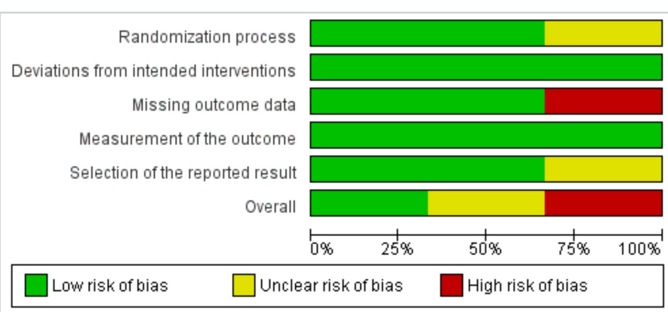

Figure 3. Risk of bias (RoB) summary

B. Postoperative pain (10-point scale)

Postoperative pain levels were substantially reduced in favor of the TW arm compared to the ME arm [n=2 RCTs, SMD =-0.39, 95% CI (-0.67, -0.12), p=0.005]. In subgroup analysis, the effect size was not statistically significant on postoperative day 1 [n=2 RCTs, SMD =-0.36, 95% CI (-0.75, 0.03), p=0.07], however; on postoperative pain day 5 there were a substantially reduction that favor TW arm compared to the ME arm [n=2 RCTs, SMD=-0.43, 95% CI (-0.83, -0.04), p=0.03]. The gathered analyses were homogenous (chi-square p>0.1, I-square <50%) (Figure 5).

In the subgroup analysis by age groups, on day 1 there were no substantial differences between the TW and ME arms in the adults subgroup [n=1 RCTs, MD=-0.41, 95% CI (-0.93, 0.11), p=0.12], and there were no substantial differences between the TW and ME arms in the pediatric subgroup [n=1 RCT, MD =-0.29, 95% CI (-0.89, 0.32), p=0.35] (Supplemental Figure 1). Similarly, on day 5, there was a substantial difference between the TW and ME arms in the adult [n=1 RCTs, MD =-0.58, 95% CI (-1.11, -0.06), p=0.03], and there were no substantial differences between the TW and ME arms in the adult [n=1 RCT, MD=-0.23, 95% CI (-0.83, 0.37), p=0.46], respectively, (Supplemental Figure 2).

C. Postoperative bleeding

Overall, there was no substantial variation between the TW and ME arms regarding postoperative bleeding [n=3 RCTs, RR =0.40, 95% CI (0.06, 2.62), p=0.34]. Subgroup analysis revealed no substantial variation between the two arms regarding the rates of primary bleeding [n=3 RCTs, RR =3.00, 95% CI (0.13, 70.16), p=0.49], and secondary bleeding [n=3 RCTs, RR =0.16, 95% CI (0.02, 1.29), p=0.09]. The gathered analyses were homogenous (chi-square p>0.1, I-square <50%) (Figure 6).

Discussion

This pooled analysis revealed that postoperative bleeding for tonsillectomy were similar between the ME and TW techniques. TW showed lower postoperative pain levels than

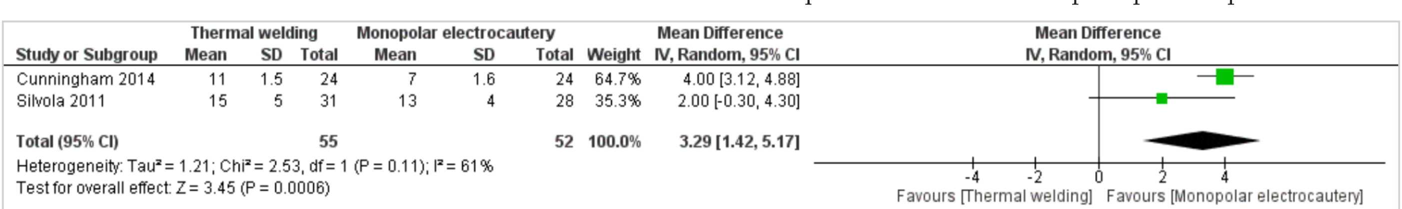

Figure 4. Meta-analysis of the mean the operation duration (min)

SD: Standard deviation, CI: Confidence interval

ME statistically but without achieving significant clinical advantage. Also, ME showed lower operative duration than TW statistically but without achieving significant clinical advantage. Since TW is more costly than ME and the utilization of the TW did not provide any apparent benefits over ME in tonsillectomy, we suggest that the cost factor should be considered when choosing one of these two procedures (21-23).

ME and TW both have the drawback of applying high heat, which might harm the adjacent mucosa and the muscle tissue, and lead to pharynx spasms (22). However, TW contains an insulating component to minimize tissue injury when utilizing this technique (16). This may result in reduced tissue injury to the pharynx muscles, pharynx spasms, as well as postoperative pain. These results aligned with our study, as the TW technique reduced postoperative pain more than ME. Comparing TW to other hot-tonsillectomy methods, Sanlı et al. (16) also concluded it to be a reliable approach in terms of tissue injury.

Comparing the TW and BE procedures, Karatzias et al. (12) discovered that the TW group experienced substantially less pain and no thermal harm to the nearby structures. In the BE arm, they also found a small amount of peritonsillar and uvula edema. Yet, according to Cunningham and Chio (21), there was no substantial statistical variation in pain levels between electrocautery and TW.

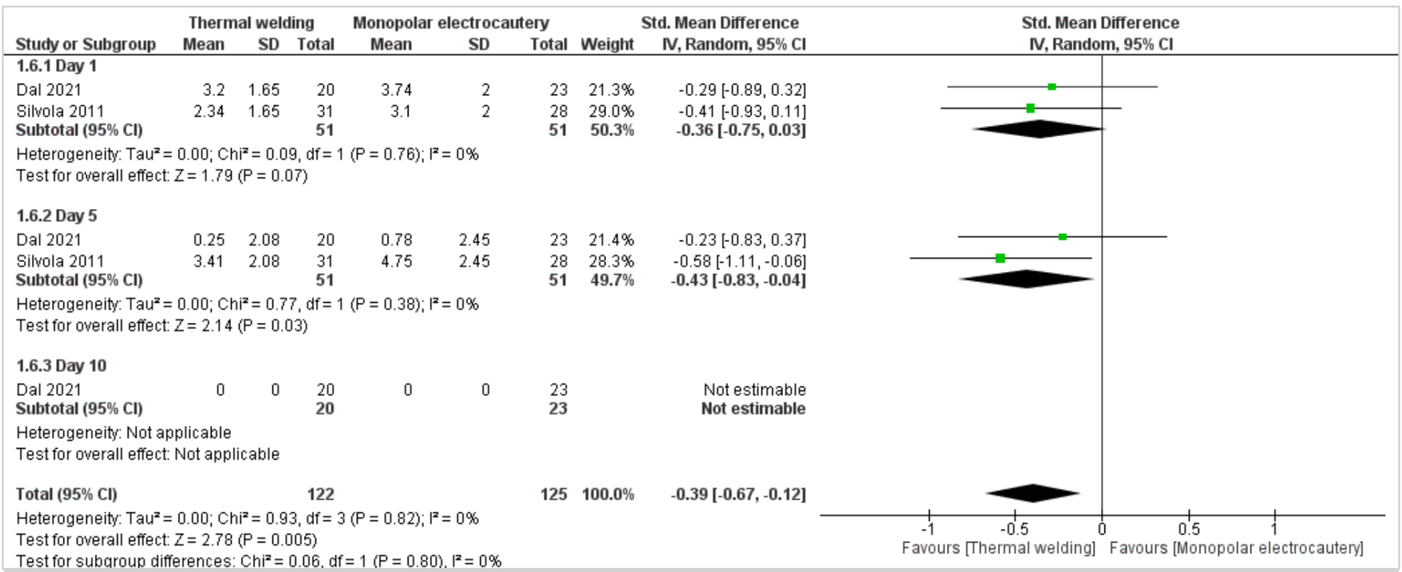

Figure 5. Meta-analysis of the mean postoperative pain (10-point scale)

SD: Standard deviation, CI: Confidence interval

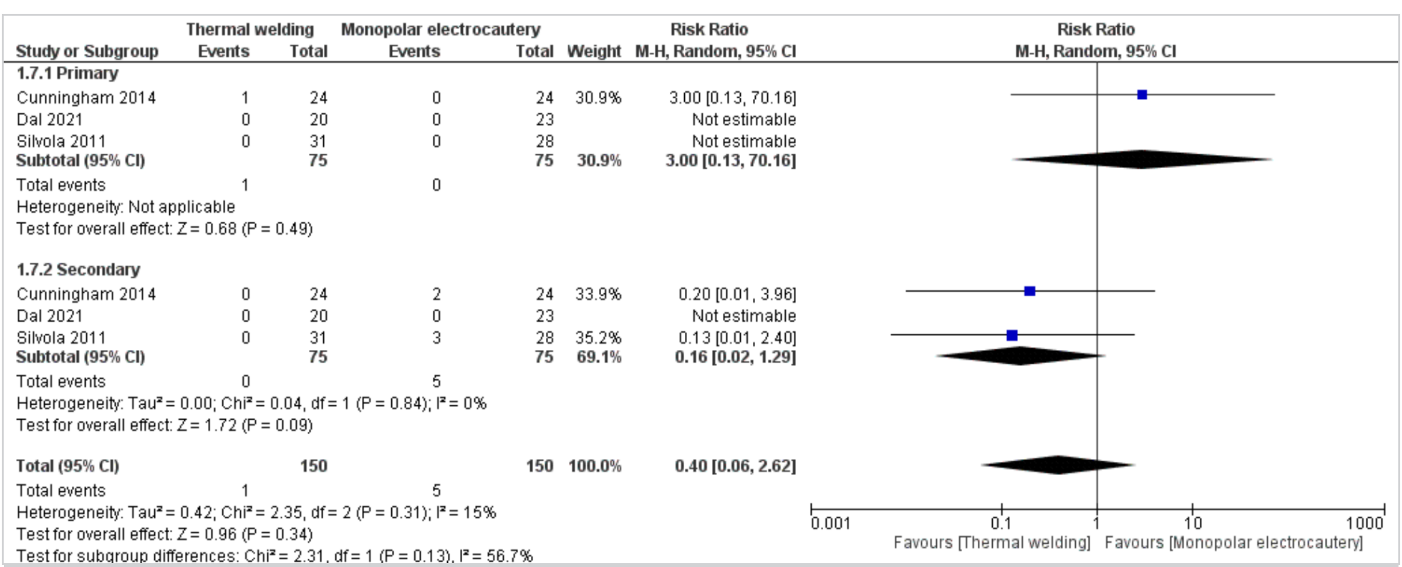

Figure 6. Meta-analysis of the rate of postoperative bleeding

SD: Standard deviation, CI: Confidence interval

A previous investigation on tonsil bed healing and the extent of the necrosis showed that the TW group performed substantially better than the ME group (21). These findings are consistent with those of Ozkiriş et al. (24) who found that the TW group had greater re-epithelization of the tonsillar fossae than the BE dissection approach provided. The amount of thermal tissue injury and pain levels were connected and found to be considerably lower in the TW group. Consequently, analysis of the thermal tissue injury can provide insight into the likely level of postoperative pain that patients will experience after any tonsillectomy approach and affects when patients are discharged from the hospital and how much the procedure costs overall.

Concerning postoperative bleeding, our gathered analysis revealed no substantial variation between the ME and TW techniques in tonsillectomy. According to Hinton-Bayre et al. (25), who reviewed the methods employed by consulting surgeons, there was no substantial variation in secondary post-tonsillectomy bleeding between the trial arms. Additionally, the authors highlighted that as a contributing factor to bleeding, surgeon experience was possibly more crucial than the technology of the tools utilized in these surgeries. According to a prior trial, however, the TW technique could cause fewer bleeding concerns than conventional tonsillectomy techniques (23). In this study, the authors demonstrated that whereas there were no cases of hemorrhage in the TW arm, three individuals in the ME arm experienced late hemorrhage. The small sample size still restricts the results of this study, and large-scale confirming RCTs are required to verify the safety of TW.

TW had the greatest rate of return to the operating room for the management of secondary hemorrhage and the greatest degrees of pain. Whereas the observed extent of the injury was less severe than that of coblation, this result could be due to the high operating temperatures for TW (10). However, when comparing coblation with the laser technique, a recent pooled analysis revealed no substantial variation between the coblation and the laser procedures in terms of postoperative pain and bleeding (26).

Regarding the duration of the operations, we found a significant difference between the TW and ME techniques (21-23). Another trial also found that using TW resulted in prolonged operating times ($p<0.001$). When total anesthetic times were compared, however, this did not result in a statistically significant extension of intraoperative time, and hence, did not result in an increase in cost (21).

Although the majority of otorhinolaryngologists are aware that several modern devices used in tonsillectomy -those used for coblation and TW, for instance- are substantially more costly than those used for ME, the increased operating time had the highest impact on cost (21-23). Another study, supporting these findings, reported a significant increase in operation times and costs in TW compared to ME (21). Yet, there is a lack in the literature concerning the cost of these new techniques. Even the few studies that discussed the cost need to be updated, as they were conducted more than 10 years ago. For example, in 2003, TW forceps cost was estimated to be approximately €280/US$340. These forceps were single-use Bayonet UltraSlim instruments (27). This finding was cost-effective in some investigations as the single-use protects against Creutzfeldt–Jakob disease transmission (12). However, a study conducted in the Turkish population in 2013 reported that the main disadvantage of TW was the cost of the procedure, which was significantly higher than those of BE and classic dissection techniques, as the cost of TW forceps was about US$310 at that time in Turkey (24).

The results of this pooled analysis provide new information. However, some of its drawbacks necessitate caution when generalizing its findings. The inability to assess publication bias and the short postoperative follow-up times are two of these drawbacks. The low number of eligible studies mainly contributed to these limitations. The included studies also revealed a discrepancy in demographic traits depending on whether the group was made up of adults or children, which could introduce bias. Histopathologic characterization of the extent of injury of TW was lacking, and further research involving a larger patient group is required to thoroughly explore the substantial variations between TW and ME.

Conclusion

This pooled analysis revealed that postoperative bleeding for tonsillectomy were similar between the ME and TW techniques. TW showed lower postoperative pain levels than ME statistically, but without achieving significant clinical advantage. Also, ME showed lower operative duration than TW statistically but without achieving significant clinical advantage. Since the TW technique is costlier than the ME and the utilization of TW did not provide any apparent benefits over ME in tonsillectomy, we suggest that the cost factor should be considered when choosing one of these two procedures. Additional well-designed RCTs with greater sample sizes are needed to fully understand and comparatively assess the morbidity rates associated with ME and TW in tonsillectomy.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: E.A., B.A., Design: E.A., B.A., M.A., K.M.T., A.A., Data Collection and/or Processing: B.A., M.A., K.M.T., A.A., Analysis and/or Interpretation: E.A., M.A., K.M.T., Literature Search: B.A., M.A., A.A., Writing: E.A., B.A., M.A., K.M.T., A.A.

Conflict of Interest: The authors have no conflicts of interest to declare.

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Main Points

- New techniques have been introduced to avoid comorbidities of tonsillectomy, such as monopolar electrocautery (ME) and thermal welding system (TW).
- Thermal welding may be related to less postoperative pain compared to ME, but this is still without significant clinical advantage.
- Since the surgical outcomes of TW and ME are similar in tonsillectomy, the cost factor may favor ME over TW.

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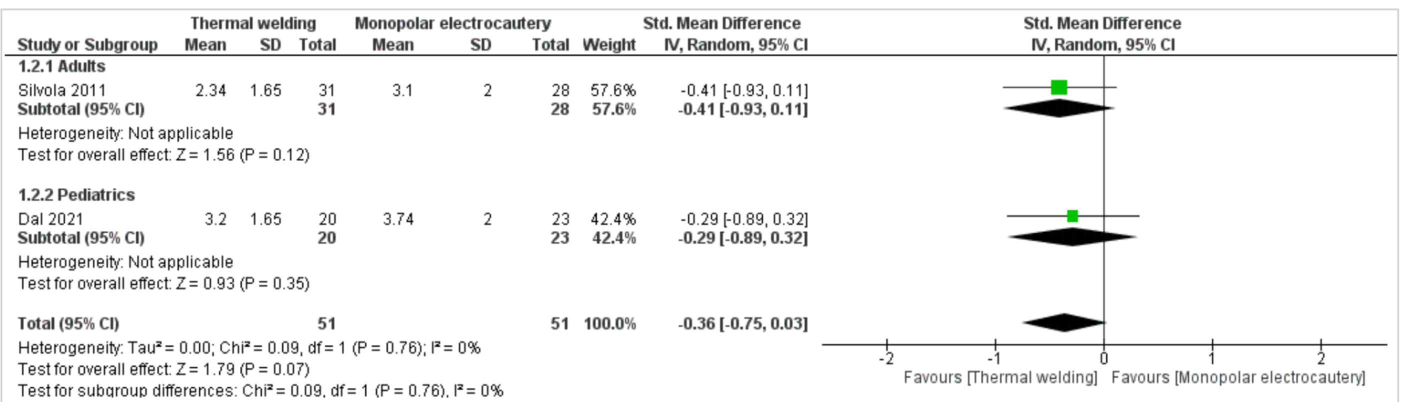
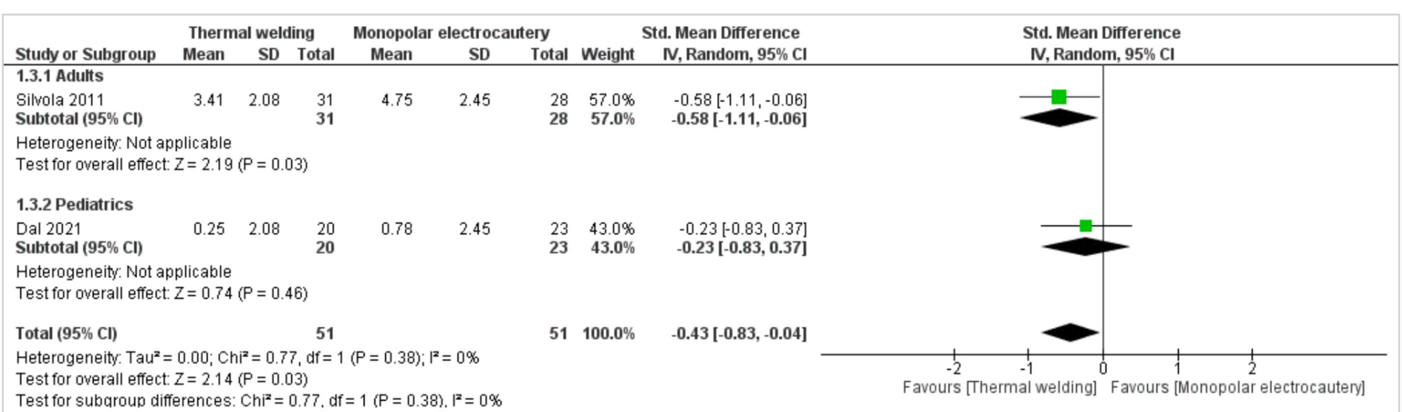


Supplemental Figure 1. Meta-analysis of the mean postoperative pain (day 1)

SD: Standard deviation, CI: Confidence interval



Supplemental Figure 2. Meta-analysis of the mean postoperative pain (day 5)

SD: Standard deviation, CI: Confidence interval