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Comparison of Consequences of Operculectomy Using Conventional Surgical Knife and Laser: A Systematic Review and Meta-analysis

Negar Kourehpaz[1], Farzaneh Pakdel[1], Katayoun Katebi[1], Parvin Sarbakhsh[2], Tannaz Abdollahzadeh Baghaei[3], Fatemeh Halimi Milani[1], Mohsen Hashemi[4*]

Abstract

Objectives: The excision of an inflamed operculum can be achieved using a conventional surgical knife (scalpel) or laser. In the current systematic review and meta-analysis, the pain and healing outcomes resulting from these two distinct operculectomy techniques were compared at various follow-up intervals.

Methods: A comprehensive electronic search was conducted for studies published in English up to September 2023, focusing on the outcomes of operculectomy procedures using scalpel and laser techniques. The search encompassed PubMed/Medline, Web of Science, Google Scholar, Embase, Cochrane, and Scopus databases. The risk of bias was assessed with Cochrane risk-of-bias tool 2. Stata 17 software was used to perform a meta-analysis.

Results: Seven studies were included, involving a total of 170 patients. The analysis revealed that there were no statistically significant differences in pain levels between the two groups on the second day ($P = 0.07$) and seventh day (P=0.10) follow-ups. Similarly, the healing index showed no significant variance between the two groups on the seventh day (P=0.34) and 14th day ($P = 0.39$) follow-ups.

Conclusions: The meta-analysis indicated that there was no statistically significant difference in pain and healing outcomes resulting from operculectomy using a scalpel versus a diode laser. Nonetheless, further randomized clinical trials with larger sample sizes are required to establish definitive results.

Systematic Review Registration: PROSPERO (CRD42022327014).

Keywords: Pericoronitis, Pain, Laser, Semiconductor, Meta-analysis

Introduction

Impaction is a prevalent dental problem in which the teeth may fail to erupt completely or partially in the dental arch (1) This situation is common in lower third molars (2). Third molars erupt into the oral cavity between the ages of 13 and 20 (3). The operculum is an epithelial tissue covering the partially impacted tooth. Its origin is a dental follicle attached to the cementoenamel junction (CEJ) (4,5). When an operculum becomes inflamed, the condition is called pericoronitis (6).

Pericoronitis is an infectious disease initiated by gram-negative bacteria (7). But its leading cause is local morphological factors (8). There is a narrow gap between the partially erupted tooth and the oral mucosa (9). This gap provides an excellent shelter for anaerobic bacteria and food accumulation. Food impaction can promote bacterial growth (10). Occlusal trauma caused by the opposing teeth can lead to more inflammation (11). Pericoronitis is a debilitating and disturbing infection that causes pain, swelling, trismus, halitosis, and even fever (12,13).

Operculectomy is the removal of the operculum over the partially erupted tooth (14). Surgical operculectomy is a less invasive technique than complete extraction of the third molar (7). A diode laser is another option for removing soft tissue lesions such as the operculum (15). Recently, lasers have played an important role in dentistry (16-20). Lasers have several advantages compared to conventional surgery, including precise incision due to improved field visibility, a sterile field of operation, healing with less scar, and decreased postoperative swelling (21). Laser-assisted surgeries require fewer local anesthetics (22). Additionally, surgical lasers can incise and coagulate simultaneously, offering improved hemostasis (23). However, lasers have certain drawbacks; they can potentially cause heat damage and necrosis (24). Moreover, their high financial cost renders them inaccessible in many dental settings. Furthermore, laser

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[1]Department of Oral and Maxillofacial Medicine, Faculty of Dentistry, Tabriz University of Medical Sciences, Tabriz, Iran. [2]Department of Statistics and Epidemiology, Faculty of Public Health, Tabriz University of Medical Sciences, Tabriz, Iran. [3]Department of Orthodontics, Faculty of Dentistry, Tabriz University of Medical Sciences, Tabriz, Iran. [4]Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Tabriz University of Medical Sciences, Tabriz, Iran.

***Corresponding Author:** Mohsen Hashemi, Tel: +9841-33355965, Email: mohsen.hashemi3263@gmail.com

Key Messages

- The postoperative pain following operculectomy using a scalpel and a diode laser was comparable.
- The wound healing process after operculectomy using a scalpel and diode laser was similar.
- Both a scalpel and a diode laser can be utilized for operculectomy.

procedures necessitate specialized training (15).

A systematic review that compared laser and scalpel regarding clinical parameters in periodontal procedures showed that, regardless of the laser protocol, there was no significant differences between laser and scalpel for pocket depth, clinical crown length, gingival index, and relapse rate. However, pain and bleeding were significantly lower in the laser group compared to the scalpel group (25).

There are controversial results about wound healing after laser operculectomy compared to the scalpel. Some studies have reported similar wound healing and re-epithelialization with both groups (24). In some other investigations, better post-operative healing has been reported in the laser group (26). Another study suggested laser operculectomy as a less painful approach; however, no discernible difference was observed in terms of wound healing between the two techniques (27). Given the varying results from different studies on the comparison of these two techniques, the current systematic review and meta-analysis seeks to consolidate findings from articles comparing the pain and healing outcomes of operculectomy procedures using these two techniques. Thus, the primary objective of this study is to determine whether differences exist between laser surgery and conventional scalpel surgery in patients with pericoronitis who underwent operculectomy, particularly in terms of pain assessed by visual analog scale (VAS) and healing evaluated by healing index.

Materials and Methods

This study was registered in the PROSPERO database (registration number CRD42022327014. In this systematic review, the main question was whether there were differences between laser surgery (Intervention), and conventional surgery with a scalpel (Control) in patients with pericoronitis who underwent operculectomy (Population) regarding the pain evaluated by VAS and healing evaluated by healing index (Outcome).

Inclusion and Exclusion Criteria

Inclusion criteria were clinical trials or cohort studies comparing two techniques of conventional surgery with a scalpel and laser for operculectomy. Only English articles were included.

Exclusion criteria were reviews, retracted articles, case reports, editorials, letters, and in vitro or animal experimental studies. The articles comparing two lasers were excluded.

Databases and Search Strategy

PubMed/Medline, Web of Science, Google Scholar, Embase, Scopus, and Cochrane databases were searched up to September 2023. The keywords were selected from medical subject heading (MeSH) and free terms. The keywords were "Operculectomy", "pericoronitis", "operculum", "Laser", "Diode laser", "laser therapy", "laser surgery", "scalpel", "surgery", "conventional surgery", "blade", "Surgical Procedures", "operative procedures", "flap", "Pain", "Post-operative pain", "Visual analog scale", "VAS", "discomfort", "laser therapy".

Every conceivable combination of these terms with "OR" and "AND" was used in the search strategy. The complete search terms are detailed in Supplementary file 1. Furthermore, an exhaustive search was carried out through the reference lists of the selected studies to identify additional relevant research. The EndNote software was utilized for reference management, facilitating the identification and removal of duplicate references.

Study Selection

The article selection process was performed according to the PRISMA flow diagram (28). Two reviewers (K.K. and N.K.) independently screened the titles and abstracts of the articles. In the event of a disagreement, a third reviewer (F.P.) was consulted. Subsequently, the full text of the articles was assessed by the same two reviewers to definitively ascertain if the studies met the inclusion criteria.

Data Extraction

Data were extracted by two independent reviewers (N.K and F.P), from the full-texts of the selected articles using a predefined electronic data extraction spreadsheet. The descriptive variables extracted were Study ID (first author's last name and publication date), country of origin, study design, sample size, gender, mean age, surgical methods, VAS score for pain, Healing Index, follow-up times, and laser wavelength. A consensus meeting was held to compare the extracted data. In instances of disagreement, a third reviewer (M.H) participated in the meeting, and a decision was reached. Two emails were dispatched with a one-week interval to the corresponding authors of articles with missing data to request the necessary information.

Assessment of the Risk of Bias

Two independent reviewers (K.K. and N.K.) utilized the Cochrane risk-of-bias tool for RCTs version 2 (RoB2) (29) to assess the selected articles. Disagreements were resolved by discussion with a third reviewer (F.P.). Articles exhibiting a high risk of bias, including those lacking a control group, were excluded from the meta-analysis.

Statistical Analysis

The mean VAS and healing index with standard deviation were calculated for the included studies. Mean difference

with 95% confidence interval was used to compare the results between two groups. Heterogeneity among studies was quantified using the I^2 and Q indices. An I^2 value exceeding 50% indicated significant heterogeneity. Given the high heterogeneity between the studies a random-effects model was utilized to combine the results. Since the total number of included studies was five, the estimation of publication bias and sub-group analysis was not feasible. For one of the studies (30) that reported a median instead of a mean value, the median was used as an alternative. Instead of standard deviation, the range divided by six was utilized. To avoid eliminating the studies with 0 standard deviations, their standard deviation was replaced with 0.0001.

The Statistical analysis was performed using the Stata version 17 software. A probability value less than 0.05 was considered statistically significant.

Grading of Recommendations, Assessment, Development and Evaluations

Additionally, the overall certainty in the estimates was qualitatively assessed by two reviewers (K.K. and M.H.), with one author (T.A.B.) adjudicating the decision in case of discrepancies, using the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) method. (31) The study design, risk of bias, inconsistency, imprecision, indirectness was considered for each outcome of interest, according to the GRADE method.

Results

Search Results

Among 486 papers initially identified, 412 studies remained after the removal of duplicates. Thirteen articles were selected to review their full text (Figure 1). According to the predetermined inclusion and exclusion criteria, seven papers compared the outcomes of the operculectomy procedure using a scalpel and laser (27, 30, 32-36), and among these, four were included in the meta-analysis (30, 32-34). The other three studies did not provide sufficient information for inclusion in the meta-analysis (27, 35, 36).

The Results of Evaluating the Risk of Bias

According to ROB2, six studies had low risk, while one had some concerns. The details are presented in Figure 2.

Characteristics of the Studies

Seven studies have been included in this systematic review. Overall, 170 patients were examined in these studies. The publication dates of the studies ranged from 2014 to 2019. Table 1 shows the descriptive characteristics of the included studies. Follow-up periods ranged from during the procedure to 30 days. VAS score was used in five studies to measure pain and ranged from 0 to 6 for the scalpel group and from 0 to 4 for the laser group. Healing was measured in two studies by healing index and ranged from 2 to 5 for both groups. All studies have compared

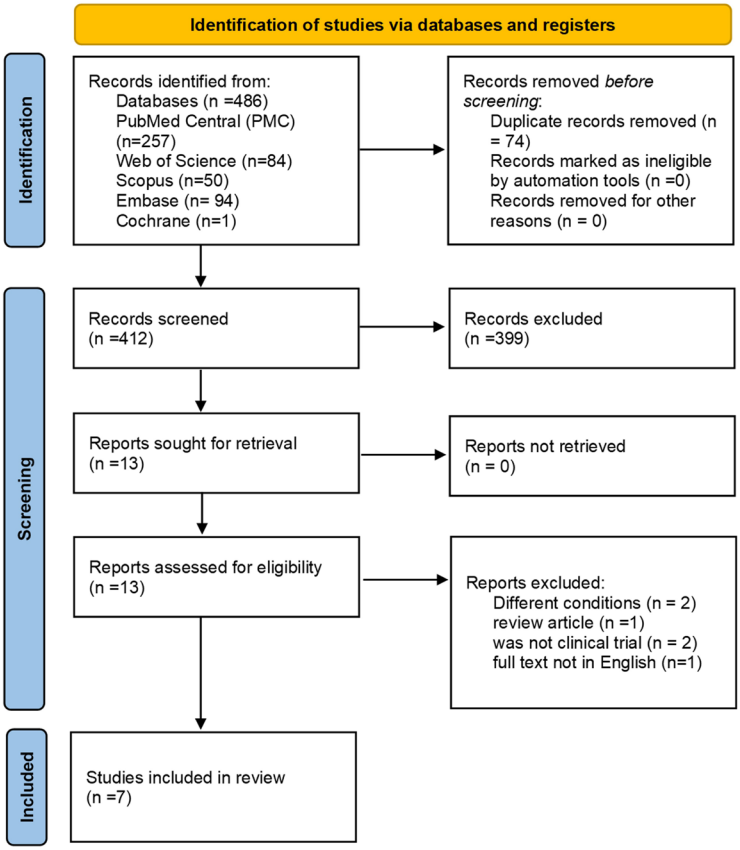

Figure 1. PRISMA Flow Diagram for the Selection of Articles.

Figure 2. Assessment of the Risk of Bias.

laser with conventional surgery (scalpel) except for one (33), which also had a third group using electrocautery for operculectomy. The included studies have chosen a diode laser, and its wavelength ranged from 810 nm to 980 nm. Overall, 55 participants were treated by laser, and 55 participants were treated by scalpel. Thirty patients received both types of treatments in the studies with split-mouth designs (34,35).

Meta-analysis

Pain on the second day of follow-up was reported in three studies (30,32,34). Twenty-five patients participated in each group (laser and scalpel). The heterogeneity between the three studies was significant ($I^2 = 89.53\%$, Q-value=25.39, $P < 0.05$). The difference in pain levels between the two groups was not statistically significant ($\theta = 1.319$ (-0.136-2.774) at a 95% confidence interval, $z = 1.78$, $P = 0.0756$). Figure 3A presents the forest plot of the meta-analysis.

Pain on the seventh day of follow-up was reported in three studies (30,33,34). Thirty patients were in the scalpel group, and 30 were in the laser group. The heterogeneity between the three studies was significant ($I^2 = 95.69\%$, Q-value = 55.73, $P < 0.05$). The level of pain difference between the two groups was not statistically significant ($\theta = 1.642$ (-0.346-3.629) at a 95% confidence interval, $z = 1.62$, $P = 0.1054$) (Figure 3B).

Healing index on the seventh day and 14th day were reported in two studies (30,32). A total number of 30 patients were investigated (15 patients in each group). In the seventh day's healing index, the heterogeneity between the two studies was significant ($I^2 = 91.06\%$, Q-value = 11.19, $P = 0.0008$). The amount of healing between the two groups was not significantly different ($\theta = -0.282$ (-0.869-0.305) at a 95% confidence interval, z=-0.94, $P = 0.3456$). Figure 4A presents the forest plot of the meta-analysis.

In the 14th day's healing index, the heterogeneity between the two studies was significant ($I^2 = 95.69\%$, Q-value = 23.20, $P < 0.05$). Based on the results of the meta-analysis, the amount of healing between the two groups was not significantly different ($\theta = 0.464$ (-0.614-1.541) at a 95% confidence interval, $z = 0.84$, $P = 0.3990$) (Figure 4B).

Certainty of Evidence According to GRADE

The certainty of pain on the second and seventh day of follow-up, as well as the Healing index on the seventh and 14th day of follow-up, was assessed as very low (Table 2) in this study. The evidence pertaining to all four outcomes was significantly impacted by the inadequate number of patients and the absence of allocation concealment. Moreover, due to the high heterogeneity among studies for all four outcomes, it is necessary to downgrade the

Table 1. The Descriptive Characteristics of the Included Studies

First Author, Year	Country	Sample Size	Age Range	Laser Wavelength (nm)
Asok 2018	India	30	17-40	810
Kumar 2015	India	10	20-40	980
Rao 2016	India	20	17-30	810
Nour 2018	Sudan	10	21-30 (80% of patients)	980
Samuel 2019	India	30	NR	810
Luchian 2014	Romania	20	13-16	940
Sabra 2014	Saudi Arabia	50	19-35	830

NR: Not reported.

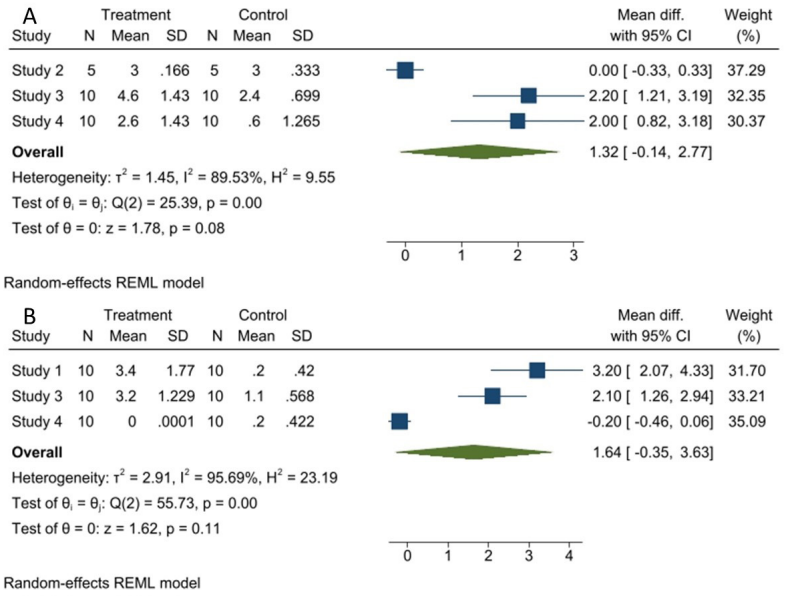

Figure 3. Meta-analysis of VAS for Pain on the Second Day (A) and Seventh Day (B) After the Operation.

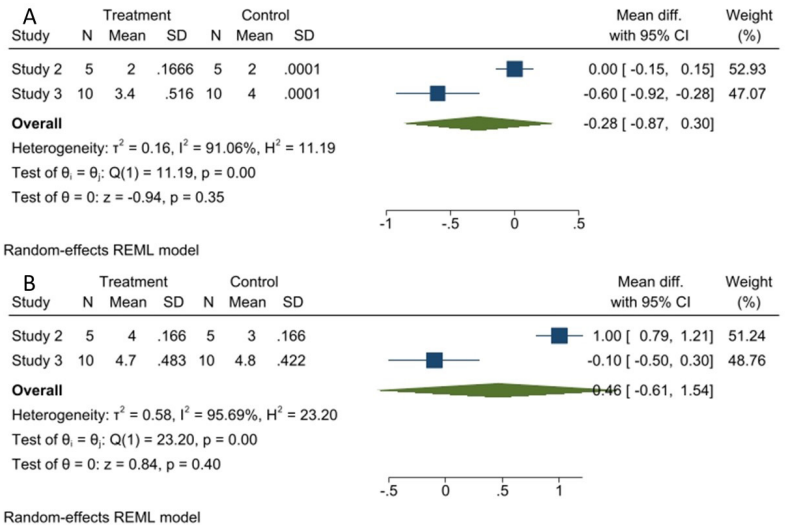

Figure 4. Meta-analysis of Healing Index on the Second Day (A) and Seventh Day (B) After the Operation.

quality of evidence by one level as a result of inconsistency.

Discussion

The operculum is a gingival flap that usually covers a part of the tooth crown. This painful inflammation happens by food debris accumulation or occlusal trauma caused by the occlusion of the opposing tooth near the operculum (38). The inflamed operculum can be removed by different techniques of operculectomy: the conventional surgical excision by scalpel, caustic agents, radiofrequency, electrocautery, CO_2, or diode laser (38-41). Operculectomy can also be done as a preventive procedure (36). In contemporary medicine, lasers are utilized across various domains for numerous applications (42,43).

The present study has reviewed the pain scores and healing index of laser operculectomy compared with conventional surgery using a scalpel. According to the meta-analysis, no statistically significant difference was found in VAS pain scores between the two groups at different follow-up times. However, there were controversial results about pain during the procedure among the included studies; Kumar et al stated that the VAS score of pain during the procedure was significantly higher in the laser group (32). On the other hand, Nour et al mentioned that pain levels during the operation were significantly lower in the laser group (34). The small sample size in these two studies could be considered the source of difference between the results.

In Kumar and colleagues' study, although pain scores

Table 2. Certainty of Evidence According to GRADE

Outcome	Number of Studies	Class of Evidence (37)	GRADE Certainty of Evidence
Pain on the second day of follow-up	3	II	⊕◯◯◯ VERY LOW [a,b,c]
Pain on the seventh day of follow-up,	3	II	⊕◯◯◯ VERY LOW [a,b,c]
Healing index on the seventh day of follow up	2	II	⊕◯◯◯ VERY LOW [a,b,c]
Healing index on the 14th day of follow up	2	II	⊕◯◯◯ VERY LOW [a,b,c]

GRADE: Grading of Recommendations, Assessment, Development and Evaluations.
[a] Downgraded for serious risk of bias (lack of allocation concealment).
[b] Downgraded for very serious inconsistency.
[c] Downgraded for serious imprecision.

were higher in the laser group during the procedure, after 24-36 hours post-operatively, pain scores were the same in both groups. Comfort levels after one week were significantly higher in the laser group, and satisfaction levels three weeks after the operation were better in the laser group (32).

Nour et al compared pain, plaque, swelling, gingival inflammation, bleeding, and satisfaction between two operculectomy techniques. Pain scores were higher in the scalpel group; There was no swelling in the laser group, but there was mild swelling in the scalpel group. Less inflammation was observed in the laser group. Satisfaction was measured by comparing which technique the patient preferred, and most of the participants were satisfied with the laser operculectomy. Bleeding was reported in both groups, but bleeding after laser operculectomy subsided within a day, whereas bleeding after conventional surgery continued for about a week. No sutures were needed in the laser group, which can also be considered an advantage. The soft tissue anatomy of the area surrounding the operculum and the position of the partially erupted tooth need to be examined carefully since the reduction of attached gingiva is a limitation associated with using lasers due to the elimination of the soft tissue (34).

According to the included studies, laser operculectomy exhibited better results immediately post-operation. Nour et al reported no pain in the laser group and severe pain in the scalpel group immediately after the operation (34). Samuel et al also reported better results in the laser group post-operatively (27); however, this study did not specify that post-operative scores were from which follow up time.

The studies that reported pain scores on the second day also concluded that operculectomy with laser was less painful (29,32,34). Another study that compared pain and hemorrhage between two treatment techniques (diode laser vs scalpel) for oral biopsies showed that postoperative pain and hemorrhage were significantly lower in the laser group (40).

A disparity in outcomes arose on the seventh day; specifically, both the Asok et al and Rao et al studies indicated higher VAS pain scores in the scalpel group (29,33), while the Nour et al study demonstrated slightly lower pain scores in the scalpel group (34). A review of laser surgery for oral soft tissues concluded no statistically significant difference in treatment outcome between laser and scalpel (41). There was methodological heterogeneity mainly related to protocols in the use of a laser. Various laser wavelengths, spanning from 810 to 980 nm, were employed, potentially resulting in divergent outcomes due to the differential absorption of varying laser wavelengths by tissues. In addition, because pain is subjective and was reported by patients, there was a possibility of self-report bias and placebo effect by the use of a high technology tool like a laser.

Asok et al.'s study consisted of 30 participants requiring operculectomy assigned into three groups for treatment: scalpel, electrocautery, and diode laser. Pain and healing scores were assessed on the seventh day in all three groups. The pain score of the scalpel group was significantly higher than the laser and electrocautery groups. Still, there was no statistically significant difference between the VAS scores of the laser and electrocautery groups. (33)

Luchian et al conducted a study involving 20 participants with bilateral operculum. This study stated that operculectomy with the laser method is more appreciated among the patients, and it causes less discomfort and anxiety for them, so the cooperation rate goes higher; but initially, the conventional operculectomy was performed with a surgical knife, followed by laser treatment (35). This sequence may contribute to the observed higher anxiety levels during the scalpel procedure, as the initial surgery could induce more stress.

Sabra et al concluded that operculectomy with laser is less painful, has less inflammation and less bacterial count, and has a better healing process (36). Laser beams contribute to the inactivation of bacterial cells by inducing alterations in their structure, such as disrupting the cell wall (44). Most microbes responsible for pericoronitis are obligate anaerobic bacteria and are similar to the micro-flora in periodontal pockets (45). The diode laser demonstrated a clear anti-bacterial effect by reducing obligate anaerobes more than the scalpel group (36).

Sabra concluded a better healing process in the laser

group, although there are contradictory results about the healing pace in surgical wounds caused by laser compared to the scalpel. In Asok and colleagues' study, wound healing was satisfying in all three groups, but two patients in the laser group displayed delayed healing (33). Nour et al stated that there is no significant difference between the techniques concerning wound healing (34).

On the seventh day after the operation, Kumar et al reported similar healing index scores for the scalpel and laser groups, but Rao et al reported a higher score for the laser group. On the 14th day following the procedure, Kumar et al observed superior healing scores in the scalpel group compared to the laser group in their study, whereas the findings were reversed in Rao and colleagues' study. The meta-analysis revealed no statistically significant difference in wound healing on the seventh day and 14th day between the two techniques of operculectomy. (30,32). A clinical trial about soft tissue healing, which compared a diode laser with a conventional scalpel, reported that both techniques have the same effect on wound healing. However, to achieve the best results, either of these techniques must be combined with improved oral hygiene (46).

Limitations of the Study

The limitation of this study lies in its exclusive comparison of two operculectomy techniques, as there is a lack of sufficient studies on operculectomy using electrocautery or alternative methods. Additionally, all evaluated studies utilized only one type of laser (diode). More clinical trials with varied follow-up times, assessing diverse outcomes beyond pain and healing using appropriate measurement methods and larger sample sizes, are needed.

Conclusions

This systematic review and meta-analysis revealed no significant difference in the pain and healing outcomes resulting from operculectomy using a scalpel versus a diode laser. Nevertheless, the current literature on this topic is limited and highly heterogeneous. Consequently, the confidence in the evidence is very low, making it unfeasible to recommend a specific technique for clinical practice. Therefore, additional randomized clinical trials with larger sample sizes, standardized follow-up periods, and consistent laser protocols are necessary to obtain conclusive results.

Authors' Contribution

Conceptualization: Farzaneh Pakdel.
Funding acquisition: Parvin Sarbakhsh.
Investigation: Negar Kourehpaz, Tannaz Abdollahzadeh Baghaei, Mohsen Hashemi.
Methodology: Katayoun Katebi.
Project administration: Farzaneh Pakdel.
Supervision: Mohsen Hashemi.
Writing–original draft: Negar Kourehpaz, Katayoun Katebi, Fatemeh Halimi Milani
Writing–review & editing: Negar Kourehpaz, Farzaneh Pakdel, Katayoun Katebi, Parvin Sarbakhsh, Tannaz Abdollahzadeh Baghaei, Fatemeh Halimi Milani, Mohsen Hashemi.

Conflict of Interests

Authors have no conflict of interest.

Ethical Issues

This study was approved by the ethics committee Tabriz University of Medical Sciences (IR.TBZMED.REC.1401.079).

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Supplementary files

Supplementary file 1. The search strategies in the databases.

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