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Literature Review

Comparative Evaluation of Scalpel, Electrosurgery, and Laser in Periodontal Surgery: A Systematic Case Review

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KEYWORDS

electrosurgery;
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periodontal surgery;
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ABSTRACT

In periodontal surgery, utilizing a conservative approach yields more aesthetically pleasing outcomes while reducing patient morbidity and tissue damage. The development of tools such as electrosurgery and lasers for periodontal treatment has facilitated the implementation of these conservative procedures. This study aims to evaluate the efficacy, outcomes, and postoperative complications of scalpel, electrosurgery, and laser techniques in the periodontal surgery. This article was created by making a research question using the PICO method and searching for articles from PubMed/MEDLINE, Web of Science, Scopus, ScienceDirect, and Google Scholar from 2019-2023. This study used the PRISMA standard guidelines. Almost all studies in this systematic case review compared the three therapies in treating gingival hyperpigmentation. Only one study discussed the treatment of gingival enlargement using the gingivectomy method. Laser use in periodontal surgery is best compared to electrosurgery or scalpel in effectiveness, quality, outcome, postoperative complications, and wound healing. Dry and bloodless surgical wounds, instant sterilization of the surgical area, reduced bacteremia, mechanical trauma, minimal postoperative swelling and scarring, and minimal postoperative pain point to the effectiveness of using lasers compared to surgery with electrosurgery or scalpel techniques. Laser therapy in periodontal surgery is superior to scalpel and electrosurgery, offering faster treatment, fewer postoperative complications, enhanced wound healing, and higher patient satisfaction. These findings support the adoption of laser techniques for optimal clinical and patient outcomes.

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INTRODUCTION

In periodontal surgery, conservative surgical therapy represents the optimal approach.¹ However, even when isolated areas are addressed through traditional flap surgery techniques, this often necessitates relatively extensive incisions, extending to adjacent healthy periodontal area.² Despite the objective of such extensive tissue reflection being to enhance visibility and accessibility of the surgical field, it can lead to attachment loss in otherwise healthy areas.³⁻⁵ This attachment loss can result in complications such as thermal sensitivity, food impaction, and aesthetic concerns.⁶ Recent clinical innovations in flap design and management have enabled the performance of periodontal surgery focused solely on the damaged tissue, thereby minimizing treatment failures compared to traditional flap methods.⁷ Consequently, utilizing a conservative approach yields more aesthetically pleasing outcomes while reducing patient morbidity and tissue damage.

In the medical field, the term "conservative surgical procedures" refers to the ability to execute standard surgical interventions and achieve comparable or superior outcomes using less surgical openings than conventional methods.⁸ These less incisions result in less postoperative discomfort, faster healing, reduced tissue damage, and similar or improved long-term surgical results. Technological advancements have made it possible to access the operating area through less incisions.¹

The development of tools such as electrosurgery and lasers for periodontal treatment has facilitated the implementation of these conservative procedures.⁹ Over the past decade, numerous reports have evaluated conservative surgical procedures for the treatment of periodontal infrabony defects, utilizing flap designs with minimal incisions and adequate elevation to access the defect.^{10,11} These techniques are believed to reduce surgical trauma and enhance wound healing. However, there are several challenges that underscore the necessity of this study. Firstly, the lack of comprehensive comparative studies between different conservative surgical methods such as scalpel, electrosurgery, and laser creates a gap in understanding the relative effectiveness of these techniques. Secondly, the variability in postoperative outcomes and patient complaints with each method needs systematic evaluation to inform best practices. Thirdly, the long-term impact of these different surgical approaches on periodontal health and aesthetics remains unclear.

This systematic review aims to address these issues by evaluating the efficacy, outcomes, and postoperative complications of scalpel, electrosurgery, and laser techniques in the surgical treatment of periodontal surgery. This analysis, based on various clinical case reports, will provide a clearer understanding of the comparative benefits and limitations of each technique,

thereby guiding future periodontal surgical practices.

MATERIALS AND METHODS

Search Methodology

This study discusses the use of scalpel, electrosurgery, and laser in periodontal surgical therapy which has been reported from various published case reports in English for the last 5 years. The case report will be reviewed to evaluate the comparison of the three periodontal surgical methods based on their efficacy, and complaints during and after treatment in patients. Sources of articles collected from PubMed/MEDLINE, Web of Science, Scopus, ScienceDirect, and Google Scholar with search methods using the keywords periodontal surgery, scalpel/conventional periodontal surgery, electrosurgery in periodontal treatment, and laser in periodontal treatment. The selected articles were published in 2019-2023.

Focused Questions

This systematic case review used standard PRISMA guidelines (Preferred, Reported, Items for Systematic Review and Meta-analysis) with a research design using observational studies in case-control articles. Questions were also prepared using the PICO (Patients, Intervention, Comparison, and Outcome) method.

Patients: Patients undergoing periodontal surgical procedures with various surgical therapy approaches. Intervention: Periodontal surgical therapy by producing minimally invasive surgical therapy, either conventional surgical procedures using a scalpel, electrosurgery, or laser. Comparison: The surgical technique uses a scalpel, electrosurgery, and laser. (i) Conventional surgical technique is a technique that uses a scalpel to make a flap incision in the gingiva in a surgical treatment procedure.⁹ (ii) Electrosurgery is a soft tissue surgical technique that uses an electric current converted into heat whose surgical endpoint varies based on the shape of the wave and results in drying, to provide coagulation or shallow or deep skin cutting.¹² Whereas (iii) Laser is an acronym that means Light Amplification by Stimulated Emission of Radiation, which is a surgical technique that uses laser light energy to cut soft tissue and hard tissue.¹³ Outcome: Analysis of the efficacy, quality, results, and postoperative complications of the three periodontal surgical techniques used. Study Design: This study examines several case reports and interventional-based studies (trials) published in English.

Criteria of Eligibility

Articles were selected based on inclusion criteria: (1) articles relevant to periodontal surgery in dentistry, (2) clinical trials, (3) case reports, (4) in English, and (5) published in 2019-2023. The things that are excluded from this study are reviews, letters to the editor, and article comments.

Quality Assessment of Studies

Quality assessment of the included articles was carried out according to standard parameters described in the Cochrane Handbook for Systematic Reviews of Interventions (v5.1.0)¹⁴. The parameters were randomization of the type of periodontal surgery, blinding procedure, statistical analysis used and clearly stated, measurement of multiple variables, explicit inclusion and exclusion criteria, understandable examiner reliability tested, and reported all expected results. The author reviews and surveys each selected article for predetermined consideration criteria and directs an impartial assessment, and any ambiguities are resolved by discussion and agreement or through consultation with an expert as a third reviewer. Due to the heterogeneity of outcomes and variables in the selected studies, the research team was unable to perform a meta-analysis in the current review.

RESULTS

Search Results

The main search identified 98 articles based on key terms. After that, an article search was conducted for the last 5 years, and 28 articles were filtered based on title and abstract. The search was further narrowed, and 19 irrelevant articles were excluded. The remaining 9 full-text articles were assessed for eligibility. Additionally, a further 5 full-text articles were excluded. The 4 relevant articles were finally included and analyzed in the review. The PRISMA flowchart for the literature search strategy is described in Figure 1.

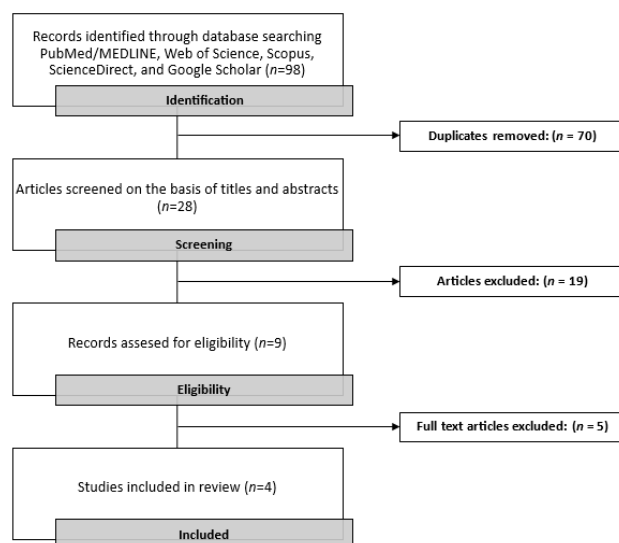


Figure 1. PRISMA flow chart.

Characteristics of Reviewed Studies

The articles reviewed in this study were taken from articles published from 2019-2023. Study of case reports comparing periodontal surgical therapy using a conventional scalpel, laser, and electrosurgery

techniques. The general characteristics of the case reports reviewed are depicted in Table 1.

Table 1. General characteristics of case reports based on the standard Cochrane Handbook for Systematic Review of Interventions (v5.1.0)

Quality Assessment	Articles			
	Jagannathan R, et. al. ⁹	Lingala S, et. al. ¹⁵	Chhina S, et. al. ¹⁶	Bhasker A, et. al. ¹⁷
Year	2020	2021	2019	2021
Randomization	Yes	Yes	No	No
Withdrawal/dropout	No	No	Yes	No
Variables measured many times	Yes	Yes	Yes	No
Sample size estimation	Yes	Yes	Yes	No
Inclusion/exclusion criteria clear	Yes	Yes	Yes	Yes
Examiner reliability tested	Yes	Yes	Yes	Yes
Expected outcomes prespecified	No	Yes	Yes	Yes
Quality of study/bias risk	Low	Low	Low	Low

General Outcomes of Reviewed Studies

The results shown from the various studies reviewed in this study are suggestive. For more details, see the general results in Table 2.

DISCUSSION

Regeneration of lost periodontal tissue has always been the ultimate goal of periodontal therapy. During the last decade, special emphasis has been placed on surgical techniques to facilitate the regeneration of periodontal tissue. Specific surgical approaches have been proposed to preserve soft tissue and to achieve rapid wound closure.

Almost all studies in this systematic case review compared the three therapies in the treatment of gingival hyperpigmentation, and only one study discussed the treatment of gingival enlargement using the gingivectomy method. Nonetheless, the use of the three surgical periodontal methods can still be compared in terms of effectiveness, quality, outcome, postoperative complications, and wound healing.

Conventional surgery using a scalpel result in quite a lot of bleeding during surgery and requires a periodontal dressing to cover the surgical wound. In contrast to electrosurgery and laser, bleeding and lower inflammatory reactions were observed in the gingival tissue. This is because blood vessels around the surgical area haemostasis occur due to the use of these two tools, so the operating area is relatively clean.¹⁸

Table 2. General outcomes of reviewed studies

Assessment Review	Jagannathan R, et. al.⁹	Lingala S, et. al.¹⁵	Chhina S, et. al.¹⁶	Bhasker A, et. al.¹⁷
Periodontal surgery	Gingival depigmentation	Gingival depigmentation	Gingival depigmentation	Gingivectomy in enlargement gingiva
Patients (number, age)	30 patients, 24-38 years old	45 patients	10 patients, newborns 18-40 years old	1 patient, 25 years old
Pain and discomfort (Visual Analogue Scale)	less pain and discomfort in the laser group	higher pain for the surgical scalpel than other groups	less pain and discomfort in the laser group	no significant difference was noted in the first 2 days, laser-treated tissues generally exhibit less pain
Treatment efficacy (duration)	Faster treatment in the laser group.	Fastest treatment in the laser group.	Faster treatment in the laser group.	Faster treatment in the laser group.
Outcome (wound, aesthetic)	Scalpel: slight redness; electrosurgery: generalized reddened areas; laser: clinically appreciable, better healing	All three techniques are effective in the management of gingival hyperpigmentation	Aesthetic results by all techniques were excellent and comparable	The laser provides more adequate haemostasis and accurate incision margins
Post-treatment complications	Less repigmentation in the laser group compared to others at the end of 14 months.	None	None	None
Wound healing	Less healing time in the laser group (1 week) compared to the scalpel and electrosurgery (2 weeks)	The fastest healing in laser, yet faster healing in the scalpel group than electrosurgery	Faster healing in the laser group	Faster healing in the laser group

This is in line with a study conducted by Hassan et. al.¹⁹ and Xu et. al.²⁰, who demonstrated relatively lesser bleeding during laser-treated surgery compared to other techniques, the difference being statistically significant. These findings are also consistent with research conducted by Lagdive et. al.²¹ and Lee et. al.²² thought because the laser has the ability to cut and agglomerate tissue. The protein coagulum that forms on the surface of the wound acts as a biological dressing and seals the ends of capillaries and venules, reducing bleeding during laser surgery.

Although laser and electrosurgery are thought to produce less soft tissue trauma than scalpels, there are differences between laser and electrosurgery surgery. The use of electrosurgery is based on the premise that electrical energy leads to the disintegration of the melanin cell molecules from the surgical area and its surroundings. In depigmentation surgery, the surgery is performed using the sides as well as tips of electrodes and, sometimes, accidentally damages adjacent tissues.²³ Electrosurgery is not specific for absorption in the target tissue and cannot control the depth of necrosis in the treated tissue. This inability to control the depth of necrosis is a significant drawback to the use of electrosurgery techniques for tissue ablation.²⁴

Electrosurgery has its limitations, as its repeated and prolonged use causes unwanted heat accumulation and tissue damage.²³

The postoperative advantages of lasers include less pain, less swelling, scar tissue formation, and good and smooth wound healing. Excellent hemostasis and good field vision are obtained during laser surgery. Some types of lasers, such as diode lasers, require a slower wound healing time than conventional surgical procedures and electrosurgery. This is because the diode laser produces a thick coagulation layer on the surface of the treated soft tissue.¹⁸

The laser depigmentation procedure compared to the scalpel procedure, had significantly less postoperative pain on the first day. The increased pain perception assessed using the Visual Analogue Scale (VAS) in the scalpel surgery method can be attributed to the fact that this procedure involves blood loss and the presence of an open surgical wound. The findings of some of these studies were similar to the research conducted by Chandna et. al.²³ who concluded that postoperative pain experienced by patients with laser treatment was less compared to the other two surgical techniques compared in this study.

In the various cases studied in this study, patients in the laser group experienced less pain compared to the electrosurgery and scalpel groups. This can be attributed to the analgesic effect of the laser due to the disruption of the release of Na⁺ and K⁺ in the cell membrane, resulting in loss of conduction impulses, or simply to the ablation of nerve endings due to the formation of coagulum proteins.²⁵

Overall, in terms of dry and bloodless surgical wounds, instant sterilization of the surgical area, reduced bacteremia, reduced mechanical trauma, minimal postoperative swelling and scarring, and minimal postoperative pain lead to the effectiveness of using lasers compared to surgery with electrosurgery and scalpel techniques. Although the results of several studies show that laser techniques showed better results, several studies with larger sample sizes are needed to prove this. The complexity of cases in various periodontal surgical therapies is also needed to compare the efficacy of therapy from conventional surgical techniques with scalpel, electrosurgery, and laser.

This review encompasses several limitations that should be acknowledged. The relatively small number of studies included, along with their heterogeneity in design, patient demographics, and clinical settings, limits the generalizability of the findings. The short follow-up periods in most studies prevent a comprehensive assessment of long-term outcomes and complications. Additionally, the variability in technological equipment, such as different types of lasers and electrosurgery units, may have affected the consistency of the results. The diverse outcome measures used across studies complicate direct comparisons, and there is a possibility of publication bias, with positive outcomes being more likely to be reported. Finally, the narrow focus of the reviewed studies, primarily on gingival depigmentation, restricts the applicability of the findings to other periodontal procedures. Future research should address these limitations by including larger sample sizes, standardized study designs and equipment, longer follow-up periods, and a broader scope of periodontal conditions.

CONCLUSION

This systematic case review evaluated the efficacy, outcomes, and postoperative effects of scalpel, electrosurgery, and laser techniques in periodontal surgery. Laser therapy consistently demonstrated superior results, including faster treatment times, reduced postoperative complications, and enhanced wound healing compared to scalpel and electrosurgery methods. Patients treated with laser techniques reported higher satisfaction due to less pain and faster recovery. Overall, laser therapy emerged as the most effective and patient-friendly approach, offering significant advantages in treatment efficiency and patient comfort. These findings

support the increased adoption of laser techniques in periodontal surgery for optimal clinical and patient-centered outcomes.

CONFLICT OF INTERESTS

No potential conflict of interest was reported by the authors.

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