International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 21s, 2025
https://www.theaspd.com/ijes.php

Efficacy Of Scalpel And Diode Laser On Gingival Depigmentation – A Systematic Review

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ABSTRACT

Background: *Gingival hyperpigmentation, common in African, Asian, and Mediterranean populations due to increased melanin production, is often a cosmetic concern. Among various treatment options, the traditional scalpel technique and the newer diode laser have both shown efficacy in reducing pigmentation. However, comparative results remain inconsistent. Hence, this systematic review aims to evaluate the efficacy of scalpel and diode laser on gingival depigmentation.*

Methods: *A systematic review was conducted following PRISMA guidelines. PROSPERO registration was done (ID: CRD42024613206). A comprehensive search strategy was employed across electronic databases, including PubMed/Medline, Embase, Scopus, and Web of Science. The systematic review was conducted using CADIMA software, with critical appraisal of included studies performed using the JBI tool.*

Results: *Out of 62 initially identified reports, only 3 split-mouth Randomized Controlled Trials met the inclusion criteria. Across all three studies, diode laser treatment significantly reduced immediate postoperative pain compared to the scalpel technique; however, pain levels were similar for both methods by the 1-week follow-up. No significant difference was observed between the two techniques in preventing gingival repigmentation across follow-up periods. Bleeding was consistently lower with the diode laser, while healing outcomes were comparable.*

Conclusion: *The diode laser obtained better results in terms of intraoperative bleeding and perception of pain for the patient. However, there were no differences in depigmentation and wound healing intensity.*

Keywords: *Scalpel, Diode laser, Gingival depigmentation, Systematic review*

INTRODUCTION

A smile is a complex facial expression conveying emotions such as pleasure, sociability, happiness, and amusement, and may also indicate self-confidence. It exerts a positive psychosocial influence, enhancing interpersonal attractiveness and approachability.[1] The esthetics of a smile are determined not only by the form and alignment of the teeth and lips but also by the appearance of the gingival tissues. Gingival hyperpigmentation, often a cosmetic concern, presents as dark or black discoloration due to excessive melanin in the gingival epithelium. This physiologic phenomenon occurs in all ethnic groups with varying intensity and distribution.[2,3] Its prevalence ranges from 0% to 89%, influenced by ethnic factors and tobacco use, and is termed physiological or racial pigmentation when genetically determined.[4-6]

The oral mucosal epithelium consists mainly of keratinocytes with melanocytes in the basal cell layer, characterized by cytoplasmic dendritic extensions and responsible for melanin synthesis.[7] Pigmented oral lesions may arise from increased melanocyte numbers or enhanced melanin production. Such pigmentation is more common in individuals with naturally hyperpigmented skin, especially those of African, Asian, and Mediterranean descent.[8,9]

Physiological gingival pigmentation often appears in childhood and may increase with age. It is usually localized, symmetrical, and affects the vestibular aspect of the attached gingiva, as well as the lips and tongue, while sparing the free gingival margin.[10,11] Gingival melanosis is a benign mucosal discoloration posing no health risk, though treatment may be sought for aesthetic or psychosocial reasons.[12-15]

Several treatment modalities are currently available for the management of gingival hyperpigmentation. Chemical methods include the application of agents such as alcohols, phenols, and ascorbic acid. Surgical approaches encompass gingival abrasion, epithelial excision with a scalpel, and various energy-based techniques, including laser ablation, electrosurgery, cryosurgery, and radiosurgery.[3]

Surgical removal of gingival melanosis is commonly done using the scalpel gingivectomy technique, which excises the pigmented gingival epithelium for a lighter, uniform appearance. Before surgery, a thorough clinical examination assesses pigmentation extent and guides the plan. Under local anesthesia, precise incisions are made along the gingival margin to remove hyperpigmented tissue while preserving healthy structures, ensuring symmetry and esthetic harmony.[16-18]

Previous literature reported that surgical excision of pigmented gingival epithelium is a cost-effective method with a low recurrence rate. However, it has drawbacks such as intraoperative and postoperative bleeding, pain, discomfort, and the need for a periodontal dressing, and is contraindicated in patients with a thin gingival biotype or narrow interdental papillae.[16]

To overcome the limitations of the scalpel technique, laser technology has been introduced in dentistry since the 1960s, following its initial use in dermatology, as an alternative to certain drawbacks of conventional treatments. The diode laser, operating at 800–1000 nm, is a high-power semiconductor device enabling precise soft-tissue incision with effective hemostasis. It produces a narrow thermal necrosis zone (<1 mm), minimizing collateral tissue damage, and has bactericidal effects that reduce microbial load in periodontal pockets.[19] In esthetic dentistry, it is used for gingival depigmentation and tooth bleaching, efficiently reducing melanin pigmentation and removing enamel stains to enhance the esthetics. Advantages include high precision, reduced intraoperative discomfort, better hemostasis, faster healing, and greater patient satisfaction. With technological advancements, diode lasers are expected to play an increasingly important role in modern dental practice.[15]

Previous study states that diode laser energy is transmitted through optical fibers and delivered via synthetic sapphire tips in contact mode for precise soft-tissue incision or ablation. These compact, portable devices operate at specific wavelengths selectively absorbed by pigmented tissues, making them effective for esthetic procedures, periodontal therapy, and soft-tissue surgery, while offering accurate, minimally invasive treatment options.[20]

Although both surgical scalpel and diode laser techniques are used for gingival depigmentation, literature shows variability in outcomes, particularly regarding recurrence rates, postoperative pain, and patient satisfaction. Many studies are limited by small sample sizes, short follow-up, and non-standardized outcome measures, hindering definitive clinical guidelines. Few have directly compared these techniques with simultaneous consideration of repigmentation and pain. This systematic review synthesizes data to provide an evidence-based evaluation of their comparative efficacy, aiding clinicians in selecting the most appropriate treatment for optimal patient care.

Hence, this systematic review aims to evaluate the efficacy of scalpel and diode lasers on gingival depigmentation.

MATERIALS AND METHODS

Review question: This systematic review was registered in PROSPERO (CRD42024613206), an international database of prospectively registered systematic reviews. It was done to ensure no duplication or overlapping reviews on this topic. This systematic review was conducted in accordance with the "Preferred Reporting Items for Systematic Reviews and Meta-Analyses" (PRISMA) guidelines.[21]

The review question was formulated based on PICO format.
(P) Population: Patients with Gingival Hyperpigmentation
(I) Intervention: Diode Laser
(C) Comparison: Scalpel
(O) Outcomes: Pain, Recurrence of Gingival pigmentation, bleeding and healing
The review question was, "Does scalpel and diode laser have efficacy on gingival depigmentation in terms of pain, repigmentation, bleeding and healing?

Eligibility criteria

[A] Inclusion criteria

- Studies involving patients with gingival hyperpigmentation
- Studies in which diode laser was used as an intervention
- Studies in which scalpel was used as a comparison
- Studies with primary outcomes assessed as postoperative pain and recurrence of gingival pigmentation, while secondary outcomes as intraoperative bleeding and healing time.

[B] Exclusion criteria

- Observational studies, Review reports, case series, in vitro and animal studies.
- Studies providing only abstract and not full text.
- Studies in other language except English.

Type of the study

This review included split-mouth randomized controlled trials that compared the efficacy of diode laser and scalpel techniques in the treatment of gingival hyperpigmentation, evaluating outcomes such as postoperative pain, gingival repigmentation, intraoperative bleeding, and wound healing.

Search Strategy for Article Identification

Two independent researchers systematically searched major databases like Medline/PubMed, Web of Science, Scopus, and Embase for randomized controlled trials published in English over the past 25 years, up to December 2024 (Table 1).

Table 1: Search strategy for databases

DATABASE	SEARCH STRATEGY
PubMed	("scalpel"[All Fields] OR "scalpels"[All Fields]) AND ("lasers, semiconductor"[MeSH Terms] OR ("lasers"[All Fields] AND "semiconductor"[All Fields]) OR "semiconductor lasers"[All Fields] OR ("diode"[All Fields] AND "laser"[All Fields]) OR "diode laser"[All Fields]) AND (("gingiva"[MeSH Terms] OR "gingiva"[All Fields] OR "gingival"[All Fields] OR "gingivally"[All Fields] OR "gingivals"[All Fields] OR "gingivitis"[MeSH Terms] OR "gingivitis"[All Fields] OR "gingivitides"[All Fields]) AND ("hyperpigmentated"[All Fields] OR "hyperpigmentation"[MeSH Terms] OR "hyperpigmentation"[All Fields] OR "hyperpigmentations"[All Fields] OR "hyperpigmention"[All Fields])) AND (("gingiva"[MeSH Terms] OR "gingiva"[All Fields] OR "gingival"[All Fields] OR "gingivally"[All Fields] OR "gingivals"[All Fields] OR "gingivitis"[MeSH Terms] OR "gingivitis"[All Fields] OR "gingivitides"[All Fields]) AND ("depigmentations"[All Fields] OR "hypopigmentation"[MeSH Terms] OR "hypopigmentation"[All Fields] OR "depigmentation"[All Fields]))
Web Of Science	((TS=("gingival depigmentation")) OR TS=(gingiva)) AND (((TS=(scalpel)) OR TS=("surgical knife")) OR TS=("disposable scalpel")) AND ((((((TS=(laser)) OR TS=(lasers)) OR TS=("diode laser")) OR TS=("laser ablation")) OR TS=("diomed 360")) OR TS=("diode laser device"))
Scopus	((TITLE-ABS-KEY ("gingival depigmentation") OR TITLE-ABS-KEY (gingiva))) AND ((TITLE-ABS-KEY (scalpel) OR TITLE-ABS-KEY ("surgical knife") OR TITLE-ABS-KEY ("disposable scalpel"))) AND ((TITLE-ABS-KEY ("diode laser") OR TITLE-ABS-KEY (laser) OR TITLE-ABS-KEY (lasers) OR TITLE-ABS-KEY ("laser ablation")))

Embase	'gingival depigmentation'/exp AND ('scalpel'/exp OR 'Fasciotome' OR 'disposable scalpel' OR 'one-piece scalpel' OR 'reusable scalpel' OR 'scalpel' OR 'scalpel, device (physical object)' OR 'scalpel, one-piece' OR 'scalpel, reusable' OR 'scalpel, single-use' OR 'single-use scalpel' OR 'surgical knife' OR 'surgical knife, device (physical object)') AND ('diode laser'/exp OR 'DIOMED 630' OR 'ELVeS Radial' OR 'Echolaser X4' OR 'Haemato LS PDT 660' OR 'Mediostar' OR 'QuadroStar PRO' OR 'Quanta B' OR 'Quanta C Star' OR 'QuardoStar PRO' OR 'Vari-lase' OR 'WISER (diode laser)' OR 'diode laser' OR 'diode laser cable' OR 'diode laser cable extractor' OR 'diode laser device' OR 'diode laser systems' OR 'diode lasers' OR 'general use diode laser' OR 'general/multiple surgical diode laser system' OR 'laser, diode' OR 'laser, semiconductor' OR 'lasers, semiconductor' OR 'multiple surgical diode laser system' OR 'semiconductor laser' OR 'semiconductor laser device' OR 'semiconductor laser device (physical object)' OR 'semiconductor lasers' OR 'surgical diode laser cable extractor')

Screening of Articles

Screening of articles was done using CADIMA software. Upon merging the articles from various databases, duplicates due to repetition of the same article across different indexing sources were identified and removed. Studies that failed to satisfy the specified PICO criteria were excluded. Titles and abstracts were independently screened by two primary reviewers, with any disagreements regarding article selection resolved by a third author. Following this, the full texts of all eligible articles were independently reviewed by the two primary reviewers.

Data Extraction

For all studies that fulfilled the eligibility criteria, data extraction was performed by two authors which included: (a) Author and year of publication, (b) Type of study, (c) Study location, (d) Data source, (e) Characteristics of the study group, (f) Characteristics of the control group, (g) Evaluation parameters, (h) Evaluation period, (i) Results in the test group and control group in terms of pain, repigmentation, bleeding and wound healing, (j) Statistical significance between groups, and (k) Overall inference.

Risk of Bias

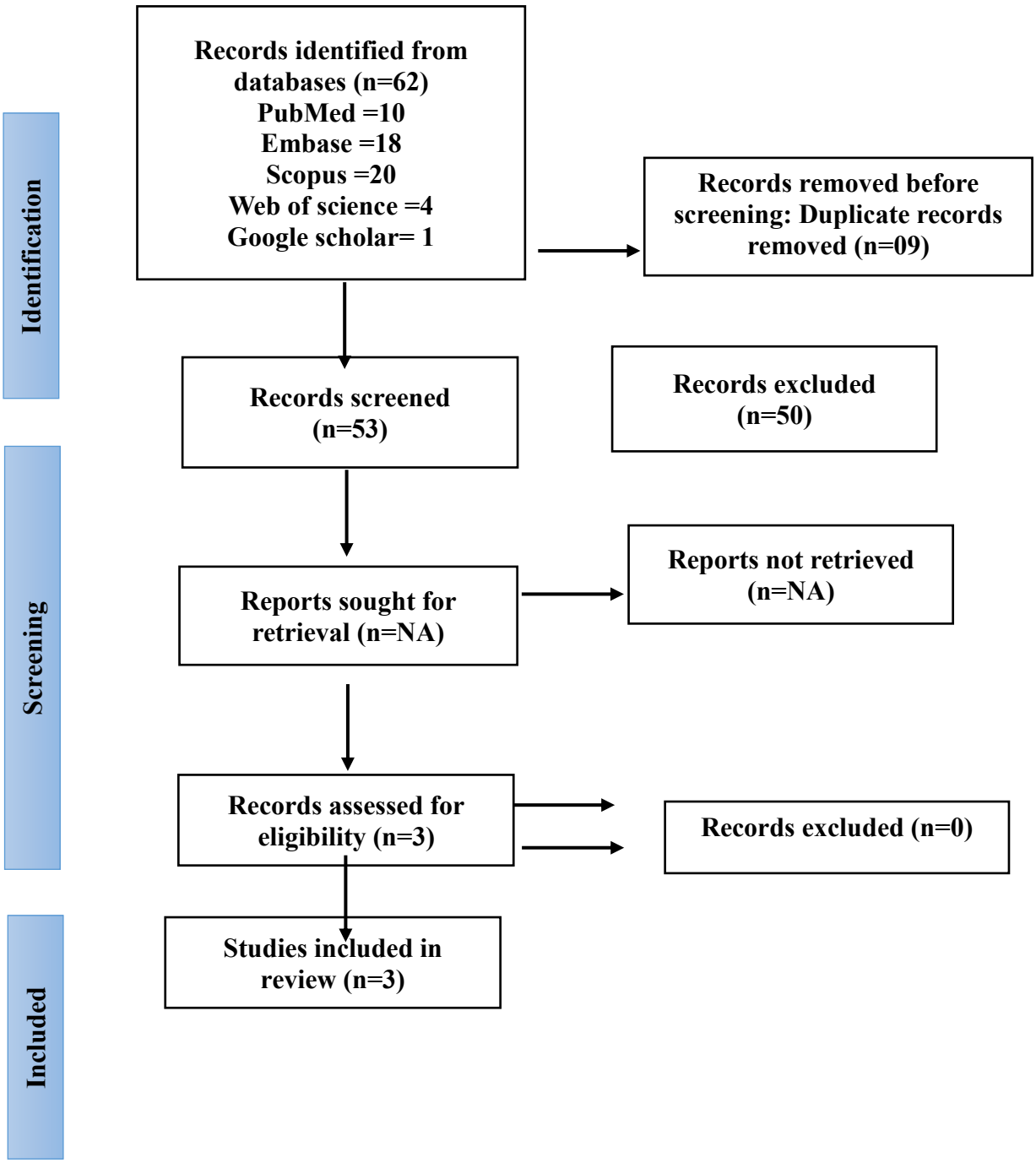
Risk of bias among the selected studies was evaluated using the Joanna Briggs Institute (JBI) critical appraisal tool for RCT(2023).[22] This comprehensive tool consists of four distinct domains of assessment, providing the overall risk of bias associated with each study. Each domain is structured with a set of targeted questions designed to elicit information regarding specific methodological aspects of the studies in question. Responses to each item are grouped into one of four categories: “yes,” “no,” “unclear,” or “not applicable. This systematic categorization facilitates a clear understanding of the quality of the evidence presented in each study, reflecting its overall compliance with established quality criteria and fulfillment of necessary methodological requirements.

RESULTS

Study Selection and Inclusion

Initially, 62 studies were found, from which 53 were selected after removing 9 duplicates. These 53 studies were then screened by reading the titles and abstracts, and 3 were selected. The full text of these 3 studies was accessed and selected (Figure 1).

Flowchart 1: PRISMA flowchart showing the inclusion process of the study



General Study Characteristics

A total of three studies were included in this systematic review following a comprehensive screening process that involved removing duplicates, screening titles and abstracts, and conducting full-text reviews. Only split-mouth design studies were included, while other randomized controlled trial (RCT) designs were excluded. All included studies evaluated the efficacy of diode laser as the experimental intervention, with scalpel serving as the control. These studies, conducted across various geographical regions, reported follow-up periods ranging from three to twelve months. Clinical parameters assessed included gingival repigmentation, postoperative pain, wound healing, and intraoperative bleeding, providing insights into both short- and long-term outcomes of the interventions (Table 2).

Table 2: General characteristics of the included studies

Author & year	Study design	Sample size	Age group	Study duration	Outcomes measured

Grover et al, 2014	Split mouth Randomized controlled trial	20	15-35	3 months	Pain, Gingival repigmentation, Wound healing, Bleeding
Suragimath et al, 2016	Split mouth Randomized controlled trial	12	18-40	12 months	Pain, Gingival repigmentation, Wound healing, Bleeding
Chandra et al, 2020	Split mouth Randomized controlled trial	20	20-35	9 months	Pain, Gingival repigmentation, Wound healing, Bleeding

Primary Outcome - Pain

The primary outcome, postoperative pain, was consistently assessed across all three studies using the Visual Analog Scale (VAS). Diode laser treatment demonstrated a statistically significant reduction in immediate postoperative pain compared to the scalpel technique (Table 3).

Pain assessment after 24 hours

Across all three studies, pain levels at 24 hours postoperatively were consistently higher with the scalpel technique compared to the diode laser. Mean VAS scores for the scalpel ranged from 3.5 to 3.75, while diode laser scores ranged from 1.5 to 2.5. Similarly, pain incidence data showed more patients experiencing mild to moderate pain with the scalpel, whereas a greater proportion reported no pain or only mild pain with the diode laser. Overall, diode laser treatment provided better immediate postoperative comfort than the scalpel technique.

Pain assessment after 1 week

At the 1-week follow-up, pain levels were similar for both the scalpel and diode laser techniques, with no statistically significant differences reported. Mean VAS scores for the scalpel ranged from 1.5 to 1.85, while diode laser scores ranged from 0.083 to 1.25. Pain-free rates were high in both groups, reaching 85% for the scalpel and 100% for the diode laser, with no cases of moderate pain in either. Overall, although diode lasers provided greater pain relief in the immediate postoperative period, by one week, both methods showed comparable comfort levels (Table 3).

Table 3: Primary outcome – Pain

Author & year	**Follow-up**	**Scale used**	**Diode Laser**	**Scalpel**	**Inference**
Grover et al, 2014	Day 1	VAS	2.5±2.524	3.75±2.826	Not statistically significant
	Day 7		1.25±1.860	1.85±2.300	Not statistically significant
Suragimath et al, 2016	Day 1		1.5±0.5222	3.5±0.7977	**Statistically significant**

	Day 7	VAS	0.0833±0.287	1.5±0.5222	Not statistically significant
Chandra et al, 2020	Day 1	VAS	40% no pain, 60% mild pain, 0% moderate pain	0% no pain, 70% mild pain, 30% moderate pain	**Statistically significant**
	Day 7		100% no pain, 0% mild pain, 0% moderate pain	85% no pain, 15% mild pain, 0% moderate pain	Not statistically significant

Primary Outcome - Gingival repigmentation

Gingival repigmentation was assessed in three studies using the Dummett Oral Pigmentation Index (DOPI) and the Melanin Pigmentation Index (MPI). Grover et al.[23] observed that after 3 months, mild pigmentation occurred in 20% of diode laser cases and 35% of scalpel cases. Chandra et al.,[24] with a 9-month follow-up, reported 65% mild pigmentation for diode laser and 50% for scalpel. Suragimath et al.,[3] using the MPI, found mean scores after 6 months of 0.31 ± 0.48 for diode laser and 0.23 ± 0.36 for scalpel. Across all studies, the differences between the two techniques were not statistically significant, indicating similar effectiveness in preventing gingival repigmentation (Table 4).

Table 4: Primary outcome – Gingival Repigmentation.

Author & Year	**Technique used**	**Scale used**	**Duration**	**Diode Laser**	**Scalpel**	**Inference**
Grover et al 2014	At baseline	DOPI	3 months	Moderate and Heavy clinical pigmentation	Moderate and Heavy clinical pigmentation	Not statistically significant
	After follow-up			20% mild pigmentation	35% moderate pigmentation	Not statistically significant
Suragimath et al & 2016	At baseline	MPI	6 months	0.58+-0.51	0.58+-0.51	Not statistically significant
	After follow-up			0.31+-0.48	0.23+-0.36	Not statistically significant
Chandra et al & 2020	At baseline	DOPI	9 months	Moderate and Heavy clinical pigmentation	Moderate and Heavy clinical pigmentation	Not statistically significant
	After follow-up			65% mild 10% moderate 5% heavy	50% mild 25% moderate 10% heavy	Not statistically significant

Secondary outcomes – Bleeding and healing

Bleeding and healing were assessed as secondary outcomes in the included studies (Table 5 & 6). Suragimath et al.[3] and Chandra et al.[24] evaluated both parameters using the scale proposed by Ishi et al., while Grover et al.[23] reported bleeding without a specific scale. The results consistently showed that bleeding was either absent or significantly lower with the diode laser compared to the scalpel, with statistically significant differences noted in two studies. In contrast, healing outcomes assessed after one week showed no statistically significant difference between diode laser and scalpel techniques across all studies.

Table 5: Secondary outcome – Bleeding

Author & Year	Technique used	Scale used	During procedure	Inference
Grover et al 2014	Diode Laser	N/A	Absent	Not statistically significant
	Scalpel		Present	
Suragimath et al & 2016	Diode Laser	Ishi et al	1.417+-0.5149	**Statistically significant**
	Scalpel		2.917+-0.2887	
Chandra et al & 2020	Diode Laser	Ishi et al	0% moderate bleeding 0% mild bleeding	**Statistically significant**
	Scalpel		45% moderate bleeding 55% mild bleeding	

Table 6: Secondary outcome – Healing

Author & Year	Technique used	Scale used	Follow after 7 days	Inference
Grover et al 2014	Diode Laser	N/A	No difference	Not statistically significant
	Scalpel			
Suragimath et al & 2016	Diode Laser	Ishi et al	1.174+-0.3898	Not statistically significant
	Scalpel		1.088+-0.2890	
Chandra et al & 2020	Diode Laser	Ishi et al	55% complete epithelization	Not statistically significant
	Scalpel		65% complete epithelization	

Risk of Bias

The methodological quality of the included studies was evaluated using the Joanna Briggs Institute (JBI) tool (2023) for Randomized Controlled Trials (RCTs)[22]. Grover et al.[23] (2014), Suragimath et al.[3] (2016), and Chandra et al.[24] (2020) showed moderate methodological quality on the JBI appraisal tool, with strengths in baseline group similarity, reliable outcome measures, and appropriate statistical analysis. Limitations included lack of allocation concealment, absence of participant and personnel blinding, and true randomization (Q2, Q4, and Q5) is reported in all three studies. Despite minor bias risks, findings are reasonably reliable, though future studies should improve reporting and bias control.

Table 7: Results following critical appraisal using the revised JBI critical appraisal tool for Randomized Controlled Trials

DOMAIN/ QUESTIONS	STUDY ID		
Bias related to selection and allocation	**Grover et al, 2014**	**Suragimath et al, 2016**	**Chandra et al, 2020**
Was true randomization used for assignment of participants to treatment groups?	N	Y	Y
Was allocation to treatment groups concealed?	N	N	N
Were treatment groups similar at the baseline?	Y	Y	Y
Bias related to administration of intervention/exposure			
Were participants blind to treatment assignment?	N	N	N
Were those delivering the treatment blind to treatment assignment?	N	N	N
Were treatment groups treated identically other than the intervention of interest?	Y	N	N
Bias related to assessment, detection and measurement of the outcome			
Were outcome assessors blind to treatment assignment?	Y	N	N
Were outcomes measured in the same way for treatment groups?	Y	Y	Y
Were outcomes measured in a reliable way?	Y	Y	Y
Bias related to participant retention			
Was follow-up complete and, if not, were differences between groups in terms of their follow-up adequately described and analyzed?	Y	Y	Y
Statistical conclusion validity			
Were participants analyzed in the groups to which they were randomized?	Y	Y	Y
Was appropriate statistical analysis used?	Y	Y	Y
Was the trial design appropriate and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?	Y	Y	Y

***** Y: Yes, N: No, U:Unclear, N/A: Not Applicable*****

DISCUSSION

This systematic review aimed to evaluate the efficacy of scalpel and diode laser on gingival depigmentation. Traditionally, scalpels have been employed as the primary treatment modality for

gingival depigmentation. However, advancements in technology have introduced diode lasers as a reliable alternative, offering advantages such as reduced pain and bleeding, along with better healing properties. This review included three studies with varying methodologies and follow-up durations ranging from three to twelve months. The primary outcomes evaluated were pain and repigmentation, while bleeding and healing were assessed as secondary outcomes.

In the present review, pain was the primary patient-centered outcome, assessed using the Visual Analog Scale (VAS). At 24 hours post-procedure, diode laser treatment resulted in significantly less pain than the scalpel, supporting its advantage in reducing immediate postoperative pain. However, by the 7-day follow-up, pain scores showed no significant difference between the two groups, indicating that the benefit of diode laser therapy is primarily limited to immediate postoperative pain relief. This may be because the pain with the scalpel at 24 hours is likely due to its more invasive nature, resulting in blood loss and a wide open wound that heals by secondary intention, thereby increasing early postoperative discomfort. By the 7-day follow-up, however, the pain levels in both groups became comparable, likely due to progressive wound healing and resolution of inflammation in the scalpel group.

These findings align with the study conducted by Chandana et al.[25] and Biswas et al.[26] who reported that laser techniques provide a more comfortable patient experience by offering greater precision and causing less heat-induced damage to surrounding tissues, thereby reducing inflammation and pain.

In this review, gingival repigmentation was evaluated using the Dummett Oral Pigmentation Index (DOPI) and the Melanin Pigmentation Index (MPI). Comparative analysis of the scalpel and diode laser techniques revealed no significant differences between the two approaches with respect to repigmentation. These findings were in agreement with the study conducted by Yadav et al.[27] who reported no significant difference between the two groups in gingival repigmentation. This may be because repigmentation is a spontaneous process attributed to the activity and migration of melanocytes from adjacent tissues. Melanocytes possess a self-sustaining reproductive capacity, and when locally depleted, they repopulate the area with the aid of keratinocyte-derived growth factors, such as fibroblast growth factor-β, which act as mitogens. Through their dendritic processes, melanocytes transfer melanosomes into keratinocytes, contributing to pigment restoration.

In this review, the secondary outcomes assessed were bleeding and healing. Bleeding was evaluated using the scale described by Ishi et al. The findings indicate a potential clinical advantage of the diode laser in achieving minimal to no intraoperative bleeding compared to the scalpel. This is consistent with the findings of Mikhail et al.,[28] who reported more bleeding with the scalpel technique compared to the diode laser. This may be due to the ability of the diode laser to induce the formation of a superficial protein coagulum at the surgical site, which effectively seals the severed ends of capillaries and venules.

Healing was assessed using the Ishi et al. healing index, and no significant difference was observed between the scalpel and diode laser techniques at the 1-week follow-up. This may be because that both methods achieve the key step in depigmentation, removal of the epithelial layer containing melanocytes, which triggers the same wound-healing process. As melanocytes are mainly in the basal epithelial layer, complete removal is essential, followed by cell proliferation and migration from the wound margins to enable re-epithelialization. Since these biological mechanisms are the same regardless of the technique used, short-term healing remains comparable. Although diode lasers reduce intraoperative bleeding through protein coagulum formation, this does not appear to enhance epithelial healing at one week.

This contrasts with the findings reported by Rajendran et al.,[29] who noted superior healing outcomes in the laser group at the 2-week follow-up. The discrepancy may be attributed to differences in follow-up duration, as certain laser-mediated benefits, such as enhanced angiogenesis, fibroblast stimulation, and accelerated epithelialization, may become more apparent during the later stages of wound repair rather than within the first week post-operatively.

Overall, this review indicates that diode laser treatment for gingival depigmentation results in reduced postoperative pain and more effective intraoperative bleeding control compared to the scalpel technique. However, no significant differences were observed between the two methods in terms of repigmentation or wound healing.

Future research should aim to address the methodological limitations identified in this review by standardizing outcome measures, increasing sample sizes, and extending follow-up periods to generate more robust evidence on their comparative effectiveness. Additionally, incorporating advanced imaging modalities and histological analyses may offer deeper insights into the biological effects of these procedures on gingival tissues.

Clinical Implications

Diode lasers can be considered a preferred option for gingival depigmentation when immediate postoperative pain reduction and superior intraoperative bleeding control are priorities. Both scalpel and diode laser techniques are equally effective in preventing long-term gingival repigmentation, and short-term wound healing outcomes remain comparable, allowing the choice of technique to be guided by patient comfort and surgical convenience. Additionally, diode lasers provide further benefits in minimally invasive soft-tissue management, which may enhance the overall patient experience. However, clinicians should also take into account factors such as cost, equipment availability, and operator expertise when deciding between diode laser and scalpel techniques for gingival depigmentation.

CONCLUSION

This systematic review comprehensively synthesized evidence from a range of clinical studies, demonstrating that diode lasers offer superior outcomes in terms of pain reduction and intraoperative bleeding control compared to the scalpel, while showing no significant differences in repigmentation or postoperative healing. Through this rigorous analysis, the review highlights the nuanced differences in the comparative effectiveness of diode lasers and scalpel techniques for managing gingival hyperpigmentation.

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