REVIEW ARTICLE

The Efficacy of Photobiomodulation in Wound healing following Gingivectomy: A systematic Review of clinical Studies

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Abstract

Background: There is a controversy regarding the efficacy of photobiomodulation (PBM) in soft tissue healing following gingival procedures. The aim of the current study was to systematically review the efficacy of PBM in wound healing following gingivectomy. The addressed focus question was, "Is PBM effective in wound healing following gingivectomy?" Indexed databases [Public/Publisher MEDLINE (PubMed), Excerpta Medica dataBASE (EMBASE), Web of Science, and Cochrane] were searched up to December 2020. The risk of bias (RoB) was assessed using Joanna Briggs critical appraisal tool for randomized control trials (RCTs) and case-control studies.

Methods: A total of eight studies, six RCTs and two case-control studies, were included in the present review. Seven studies with varying results indicated that PBM application following gingivectomy could enhance wound healing as early as 7 days and help in the reduction of postoperative pain. Wound healing was assessed using either Landry index (two studies), contour, and color of gingiva postsurgically (two studies), or visual analogue scale (VAS) scores (three studies) and plaque disclosing solution to measure keratinization in one study.

Conclusion: The efficacy of PBM in wound healing following gingivectomy is debatable as the heterogeneity associated with the included studies was high, but overall, the review supports PBM as an adjunctive tool for the promotion of wound healing following gingivectomy. The overall RoB was low in the included studies, further power-adjusted and well-designed RCTs with long-term follow-up are needed.

Keywords: Gingivectomy, Lasers, Photobiomodulation, Wound healing.

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Introduction

Gingival enlargement is a clinical term referring to an increase in the size of the gingival tissue. Histologically this can be the result of gingival hyperplasia (increase in the number of cells) or gingival hypertrophy (increase in the size of cells). The etiology can vary and is often multifactorial; local and systemic conditions, as well as idiopathic factors, may contribute to gingival enlargement.[1] Some of the most common causes can include hormonal changes during pregnancy or puberty, vitamin C deficiency, Crohn's disease, Kaposi sarcoma, and various genetic conditions; like hereditary gingival fibromatosis (gingival fibromatosis, neurofibromatosis type I, systemic hyalinosis, and Costello syndrome, etc.) lysosomal storage disorders (Hurler syndrome, Niemann-pick disease, and Cowden syndrome, etc.), vascular disorders (Sturge-Weber syndrome), and disorders associated with dental abnormalities (Wilson syndrome, Goltz syndrome, and regional odontodysplasia).[2] In addition to the aforementioned factors, systemic use of specific drugs can also be responsible for increasing the size of the gingival tissues.[3] Drug-induced gingival enlargement is an adverse effect of drugs such as phenytoin, cyclosporine, and calcium antagonists, leading to changes in the fibroblast function, which can induce the extracellular matrix to increase in the gingival connective tissue.[4] Furthermore, inflammation-induced gingival enlargement is often seen due to the host's response to bacterial plaque formation, resulting in a condition called plaque-induced gingivitis. Irrespective of the cause, gingival enlargement may be related to aesthetic changes, swelling, erythema, and bleeding.[4] In cases of esthetic problems such as a gummy smile (showing more than 2 mm of gum tissue when smiling), a surgical procedure called gingivectomy is often performed to remove the excess gingival tissue and enhance the final outcome. The management of gingival enlargement secondary to inflammation usually includes scaling and root planning to remove dental plaque and decrease the inflammatory response. In some of these cases, a gingivectomy may also be performed to eliminate suprabony pockets or pockets which do not extend beyond the mucogingival junction.[5]

Gingivectomy is generally considered an invasive procedure that can result in delayed healing and increased postoperative discomfort. More specifically, it has been shown that wound healing following gingivectomy takes place by secondary intention and usually requires 5 weeks for complete epithelization[5] and about 7 weeks for connective tissue maturation.[6] Postoperative

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pain and discomfort are two common complications following the traditional gingivectomy surgery, while excessive bleeding during the procedure impairing visibility can be an important drawback for dental professionals.[7] As a result, various other methods, including the use of lasers, electrosurgical units, and 5% paraformaldehyde or potassium hydroxide, have been previously described as useful means to perform gingivectomy.[6] Additionally, the use of antibiotics or amino acids has also been discussed with the aim of improving the healing process and patient's experience following gingivectomy.[8]

Low-level laser therapy (LLLT), also known as low-level light therapy or PBM, is one of the treatment modalities reported for facilitating the healing following gingivectomy. PBM has photochemical effects with a wavelength of 600–1070 nm in the red to near-infrared region of the spectrum. The power range employed in PBM is between 10–500 MW, which can penetrate the skin, soft and/or hard tissues.[9] LLLT and light-emitting diodes are being used to improve debridement, tissue repair, and in wound healing procedures.[10] Power density is usually with 5 W/cm^2 and is applied anywhere between 30–60 seconds a few times a week for several weeks.[9] The biostimulation property of PBM has been well-documented for postoperative analgesia to improve wound healing.[11] PBM works by the stimulation of normal functions of cells, and this is achieved by altering mitochondrial respiratory chains or by acting on the calcium channels of the cell membrane, resulting in the stimulation of cell proliferation and metabolism.[12–14] It can be delivered by various light sources, which include but are not limited to helium-neon, ruby, diode, and gallium arsenide light sources.[6]

Previous studies have shown debatable and uncertain results in regard to the effect of PBM in the facilitation of wound healing following gingivectomy. This ambiguity may be attributed to small sample sizes, methodological inconsistencies in the study protocols, and different methods of evaluation of wound healing following gingivectomy. Consequently, it is hard to establish whether PBM is an effective tool or not. The objective of this study was to systematically review the efficacy of PBM in the management of wound healing and, subsequently, pain relief following gingivectomy.

Methods

Reporting Format

This systematic review was conducted in accordance with the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).[15] Protocol number CRD42021248102 was registered in PROSPERO.

Focused Question

The addressed focused question was, "Is PBM effective in wound healing following gingivectomy?"

Patients, Interventions, Control, and Outcome (PICO)

The Patients, Interventions, Control, Outcome, and Study design (PICOS) format was based on the following: (1) P—patient who underwent gingivectomy; (2) I—use of PBM; (3) C—no use of PBM; and (4) O—improvement in wound healing.

Eligibility Criteria

The inclusion criteria included (1) original clinical studies; (2) RCTs and/or case-control studies; (3) studies reporting patients treated with gingivectomy and use of PBM; and (4) studies reporting wound healing. *In vitro* and *ex vivo* studies, case reports/series, historic reviews, commentaries, and letters addressed to the editor were excluded.

Study Selection and Literature Search Protocol

An electronic search was performed based on the PRISMA guidelines.[15] Indexed databases including PubMed/MEDLINE, Ovid, Scopus, EMBASE, and Cochrane were searched without language barrier by two authors (Talluri and Altuhafy) using various combinations of the following keywords (1) gingivectomy; (2) LLLT; (3) laser; (4) diode; (5) medium-level laser; (6) low-power laser; (7) laser therapy + gingivectomy; (8) PBM + gingivectomy; (9) medium-laser + gingivectomy; (10) mid-level laser + gingivectomy; (11) cold laser therapy + gingivectomy; and (12) cochlear laser + gingivectomy. As a second step, reference lists of potentially relevant original and review articles were hand-searched by the same authors (Talluri and Altuhafy) to categorize studies that may have remained unidentified in the initial literature search. A disagreement among the authors was resolved *via* discussion (Fig. 1). A search was performed using the

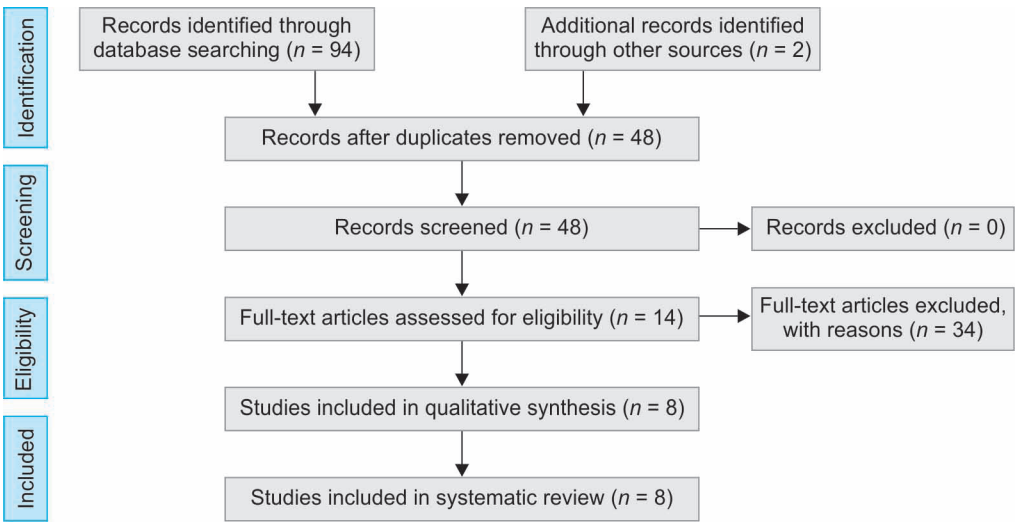

Fig. 1: Preferred reporting items for systematic reviews and meta-analyses flow chart

following mesh words ("laser s"[All Fields] OR "lasers"[MeSH Terms] OR "lasers"[All Fields] OR "laser"[All Fields] OR "lasered"[All Fields] OR "lasering"[All Fields] OR ("low"[All Fields] AND ("level"[All Fields] OR "levels"[All Fields]) AND ("laser s"[All Fields] OR "lasers"[MeSH Terms] OR "lasers"[All Fields] OR "laser"[All Fields] OR "lasered"[All Fields] OR "lasering"[All Fields])) OR "photo biomodulation"[All Fields] OR ("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 ("gingivectomy"[MeSH Terms] OR "gingivectomy"[All Fields] OR "gingivectomies"[All Fields]) AND ("wound healing"[MeSH Terms] OR ("wound"[All Fields] AND "healing"[All Fields]) OR "wound healing"[All Fields]).

Screening Method, Data Extraction, and RoB Assessment

The information was produced by presenting data according to (1) study design; (2) management of wound after gingivectomy; (3) type of PBM; and (4) study outcomes of PBM related to the management of gingivectomy. The Joanna Briggs tool was used to evaluate the RoB for RCTs and case-control studies, respectively. For RCTs, a total of 13 questions were used to critically appraise the studies included in the systematic review: (1) was true randomization used for assignment of participants to treatment groups; (2) concealment of allocation to treatment groups; (3) groups similar at baseline; (4) blinding of participants; (5) blinding of treatment providers; (6) blinding of outcome assessors; (7) treatment of groups identically other than the intervention of interest; (8) follow-up; (9) analyzing participants in the group to which they were randomized; (10) measurement of outcomes; (11) reliability of outcome measurement; (12) usage of appropriate statistics; (13) appropriateness of trial design and deviations from standard RCT. For case-control studies, a total of 10 questions were used to critically appraise the case-control studies included in the systematic review: (1) comparability of groups other than the presence or absence of the condition; (2) matching of cases and controls; (3) criteria used for identification of cases and controls; (4) measurement of exposure; (5) measurement of exposure same for cases and controls; (6) identification of confounding variables; (7) strategies to deal confounding variables; (8) measurement of outcomes in standard, reliable way for both the groups; (9) exposure period long enough to be meaningful; (10) usage of appropriate statistics. To assess the overall RoB in the included studies, a traffic light plot was used, and the RoB is low for included studies.

Results

Characteristics of the included Studies

A total of eight studies were included in the systematic review.[5,6,16–21] Out of the eight included studies, six were RCTs,[6,17–21] and two were case-control studies.[5,16] Two studies were double-blinded,[17,19] one study was single-blinded,[21] one study reported clinical and histological outcomes,[20] one study included a control group that evaluated hyaluronic acid and herbal gel,[20] and one study was a randomized case-control study.[18] The gender of the patients was mentioned in three studies.[6,17,19] The mean age of the patients ranged from 14–39 years, with a standard deviation ranging from 2 to 5.9 years and was not reported (NR) in two studies.[5,16] Inclusion and exclusion criteria were reported in five studies (Table 1).[6,17,19–21]

Characteristics of Lasers

All the studies used a diode laser with a laser wavelength ranging from 588–980 nm. Only one study reported a spectral bandwidth of 15 nm.[6] The power of the laser was NR in one study,[16] and the power of lasers in the included studies ranged from 50–300 MW. The mode of laser application was continuous in five studies[6,17–19,21] and punctual in one study,[16] and it was NR in two studies.[5,20] The duration of laser application ranged from 40–300 seconds, whereas one study did not report it.[16] The spot size (1 cm^2) was reported in three studies[6,18,21] and was NR in the rest of the studies. An energy density of 4 J/cm^2 was reported in seven studies.[5,6,16,18–21] The radiation energy (4 J) was reported in two studies.[6,21] The points of irradiation (three points) were mentioned in two studies,[6,21] whereas the area irradiated ranged from 1–3 cm^2, and was reported in four studies.[5,6,18,21] The area of laser application was noncontact in three studies,[6,18,21] contact in three studies,[5,16,20] and NR in two studies.[17,19] Total radiation energy was 12 J in two studies,[6,21] whereas irradiation at the target was reported by one study, which was 300 MW/cm^2 (Table 2).[21]

Characteristics of Study Outcomes

Periodontal dressing, Coe-Pak, was used in four studies,[5,17,18,21] two studies used no dressing,[6,19] whereas in two studies, the dressing was NR.[16,20] All studies utilized different clinical outcome parameters. Landry index of wound healing was used in two studies,[6,17] while VAS was used for evaluating healing in three studies.[18,20,21] Tissue color, contour, and wound healing were measured in three studies.[5,16,18] Surface keratinization was measured in two studies,[17,19] whereas redness, granulation tissue, bleeding, suppuration, and epithelization were measured in one study.[6] Probing depth and attached gingiva were measured in one study,[5] and histological evaluation was reported in one study.[20]

For statistical analysis, Whitney *U*-test was used for statistical analysis by three studies,[6,17,18] Wilcoxon signed-rank test in three studies.[6,19,21] Friedman test in two studies,[5,19] Analysis of variance (ANOVA) in one study,[20] sign test in one study,[16] Kursal-Wallis test in one study,[21] whereas Shapiro–Wilk test, *t*-test, and kappa test were done in one study.[18] Out of the eight studies, six studies[6,17–21] had a p value <0.05 and two studies[5,16] had a p value >0.05. The days for postsurgical evaluation were different in all the studies. One study reported outcome measurement evaluation at 3, 7, and 14 days postsurgery,[17] one study 3, 7, and 1 month postsurgically,[6] one study at the day of surgery, daily for 7 days and 15th day postsurgery,[19] one study immediately after surgery, 3, 7, 14, 21, 28, and 35th day postsurgery,[5] one study 1, 3, and 7th day of postsurgically,[20] one study 7, 14, 21, 30, and 60th day for postsurgically,[16] one study 3, 7, 14, and 28th day postsurgically,[21] one study at 1, 3, 5, and 7th days postsurgically.[18] Out of the eight studies, seven studies mentioned that PBM can be used postsurgically for better wound healing,[6,13,17–21] whereas one study reported that PBM had no clinical effect in the acceleration of gingival healing postsurgically.[16] All the included RCTs reported improvement in wound healing following PBM.[6,17–21] Reduction of postoperative pain and discomfort was reported in one study.[6] Out of the two case-control studies one study reported better wound healing with the usage of PBM,[5] and one study reported PBM has no clinical benefits in accelerating gingival healing following gingivectomy (Table 3).[16]

Table 1: Characteristics of studies

Author	Year	Study design	Total number of subjects	Subjects in PBM group	Subjects in no treatment group	Hyaluronic acid group	Herbal gel	Zone	Gender	Mean age ± standard deviation	Inclusion and exclusion criteria
17	2018	Double blind placebo controlled and split-mouth design	10	10	10	NR	NR	NR	Female = 8 Male = 2	34.5 ± 5.9 years	Reported
6	2018	Randomized control split-mouth study	40	40	40	NR	NR	NR	Female = 21 Male = 19	Females =16.81 years Males = 22 years	Reported
19	2007	Randomized double-blind placebo-controlled study	20	20	20	NR	NR	NR	Female = 9 Male = 11	24.3 years	Reported
20	2019	Randomized comparative clinical and histological study	30	10	NR	10	10	NR	NR	18-40 years	Reported
18	2020	Randomized case-control study	20	10	10	NR	NR	NR	NR	case group = 37 ± 2 control group = 35 ± 3	Inclusion = Reported Exclusion = NR
21	2020	Randomized single-blind case-control study	36	12	12	NR	NR	12	NR	14–27 years	Reported
5	2006	Case-control study	20	20	20	NR	NR	NR	NR	NR	NR
16	2013	Case-control study	11	11	11	NR	NR	NR	NR	NR	NR

NR, not reported

Table 2: Characteristics of lasers

Author	Year	Type of laser	Wave-length	Spectral band-width	Power	Mode	Duration	Spot size	Radia-tion ex-posure/ energy density	Ra-diation energy	No. of points irradi-ated	Area irradiated	Applica-tion technique	Total ra-diation energy	Irradi-ance at target
17	2018	Diode	810 nm	NR	100 MW	Continuous wave	5 minutes	NR	NR	NR	NR	NR	NR	NR	NR
6	2018	Diode	940 nm	15 nm	100 MW	Continuous wave	40 seconds	1 cm^2	4 J/cm^2	4J	3	3 cm^2	Noncon-tact	12J	NR
19	2007	Diode	588 nm	NR	120 MW	Continuous wave	5 minutes	NR	4 J/cm^2	NR	NR	NR	NR	NR	NR
5	2006	Diode	685 nm	NR	50 MW	NR	80 seconds	NR	4 J/cm^2	NR	NR	1 cm^2	contact	NR	NR
20	2019	Diode	980 nm	NR	50 MW	NR	3 minutes	NR	4 J/cm^2	NR	NR	NR	contact	NR	NR
16	2013	Ga-Al-As	670 nm	NR	NR	Punctual mode	NR	NR	4 J/cm^2	NR	NR	NR	contact	NR	NR
18	2020	Diode	660 nm	NR	50 MW	Continuous wave	80 seconds	1 cm^2	4 J/cm^2	NR	NR	1 cm^2	Noncon-tact	NR	NR
21	2020	Diode	810 nm	NR	300 MW	continuous mode	1 minute	1 cm^2	4 J/cm^2	4 J	3	3 cm^2	Noncon-tact	12J	300 MW/ cm^2

NR, not reported

Table 3: Characteristics of outcome of the study

Author	*Year*	*Periodontal dressing*	*Clinical parameters measured*	*Other outcomes measured*	*Statistical analysis*	*p-value*	*Treatment evaluation dates*	*Conclusion*
17	2018	Coe-Pak	Landry et al. healing index[27]	Surface keratinization	Mann–Whitney *U* test	$p > 0.05$ for 3 and 7th days. $p < 0.05$ for 14th day p was considered significant if <0.05	3, 7, and 14 days postsurgically	Healing may be improved using PBM after gingivectomy after 14 days
6	2018	No dressing	Landry index for wound healing[27]	Redness, Granulation tissue, bleeding, suppuration, and epithelization	Mann–Whitney *U* test; Wilcoxon signed-rank test	$p < 0.005$ p was considered significant if <0.05	3rd, 7th, and 1 month postsurgically	PBM can be used to reduce postoperative pain and discomfort and aid in wound healing
19	2007	No dressing	Plaque disclosing solution	None	Wilcoxon rank test; Friedman's test LLLT: 0.001; control: 0.001	$p < 0.001$ p was considered significant if <0.05	Day of surgery; daily for 7 days; 15th day	PB may enhance wound healing
5	2006	Coe-Pak	Tissue color; contour; status of healing wound	Probing depth; attached gingiva; wound healing	Friedman test	$p > 0.05$ p was considered significant if <0.05	Immediately; 3, 7, 14, 21, 28, and 35 days	Better healing at 7, 14, 21, 28, and 35 days
20	2019	NR	Wound healing using VAS scores	Histological evaluation	ANOVA	$p < 0.05$ p was considered significant if <0.05	1, 3, and 7th day	Ranked in order PBM > Gengigel > Hiora SG gel. The significant difference is found between the groups
16	2013	NR	Gingival color, texture, contour for wound healing	None	Sign test	$p > 0.05$ p was considered significant if <0.05	7, 14, 21, 30, and 60 days	LLLT has no clinical effect in an acceleration of gingival healing of gingivectomy wound
18	2020	Coe-Pak	Tissue color, tissue contour, wound healing status using 3-stage scale and VAS	None	Shapiro–Wilk test, Mann–Whitney *U* test, *t*-test, and Kappa test.	$p < 0.05$ p was considered significant if <0.05	Days 1, 3, 5, and 7	PBM can be used as an adjunct therapy to gingivectomy procedure
21	2020	Coe-Pak	VAS	OHIP	Kruskal–Wallis test; Wilcoxon signed rank test	$p < 0.05$ p was considered significant if <0.05	3, 7, 14, and 28 days postsurgically	PBM improves the quality of life of patients after gingivectomy

VAS, visual analog scale; OHIP, oral health impact profile; NR, not reported

Risk of Bias

Joanna Briggs critical appraisal tool was used to access RoB.[22] Joanna Briggs RoB tool for randomized control studies was used for six studies[6,17–21] and Joanna Briggs RoB tool for case-control studies was used for two studies.[5,16]

Risk of Bias for RCTs

A total of 13 questions were used to assess the RoB for randomized clinical trial studies. Out of the six RCTs, true randomization for assigning participants to treatment groups was reported in four studies,[6,19–21] and was unclear (UC) in two studies.[17,18] Concealment to

treatment groups was not applicable (NA) in four studies,[6,17,19,20] UC in one study,[21] and was NR in one study.[18] All six studies had groups similar at baseline.[6,17–21] Blinding of the participants was reported in three studies[6,17,19] and UC in three studies.[18,20,21] Blinding of the personnel providing the treatment was reported in two studies,[17,19] UC in one study,[6] and NR in three studies.[18,20,21] Blinding of the assessors was NR in five studies[6,17,19–21] and reported in one study.[18] Treatment of the groups is identical other than intervention is reported by all six studies.[6,17–21] Analyzing the participants in the groups they were randomized was NA to five studies[6,17,19–21] and was NR in one study.[18] Measurement of outcome for treatment groups was reported in six studies.[6,17–21] Measurement of outcomes in a reliable and appropriate statistical analysis way was reported in six studies.[6,17–21] The trial design was appropriate in all studies, and the overall RoB was low in all studies (Table 4) (Fig. 2).[6,17–21] Overall, the ROB was low in the RCTs.

Risk of Bias for Case-control Studies

A total of 10 questions were used to critically appraise the case-control studies.[5,16] Both studies reported that the groups were comparable to one another, and matching of the groups was done appropriately in both studies.[5,16] Identification of case and control groups was NA for one study[5] and UC in another study.[16] Measurement of exposure was standard, valid, and reliable in one study[16] and is UC in another study.[5] The measurement of exposure was the same in the case and control groups in both studies.[5,16] Confounding factors and strategies

Table 4: Joanna Briggs RoB tool for RCTs

Author	*Year*	**Study design**	*Q1*	*Q2*	*Q3*	*Q4*	*Q5*	*Q6*	*Q7*	*Q8*	*Q9*	*Q10*	*Q11*	*Q12*	*Q13*	Total
17	2018	Double blind placebo-controlled and split-mouth design	UC	NA	Yes	Yes	Yes	No	Yes	Yes	NA	Yes	Yes	Yes	Yes	81.82
6	2018	Randomized control split-mouth study	Yes	NA	Yes	Yes	UC	No	Yes	Yes	NA	Yes	Yes	Yes	Yes	81.82
19	2007	Randomized double-blind placebo-controlled study	Yes	NA	Yes	Yes	Yes	No	Yes	Yes	NA	Yes	Yes	Yes	Yes	90.91
20	2019	Randomized comparative clinical and histological study	Yes	NA	Yes	UC	No	No	Yes	Yes	NA	Yes	Yes	Yes	Yes	66.87
18	2020	Randomized case-control study	UC	Yes	Yes	UC	No	Yes	Yes	Yes	No	Yes	Yes	Yes	UC	61.5
21	2020	Randomized control study	Yes	UC	Yes	UC	No	No	Yes	Yes	NA	Yes	Yes	Yes	Yes	66.67

UC, unclear; NA, not applicable

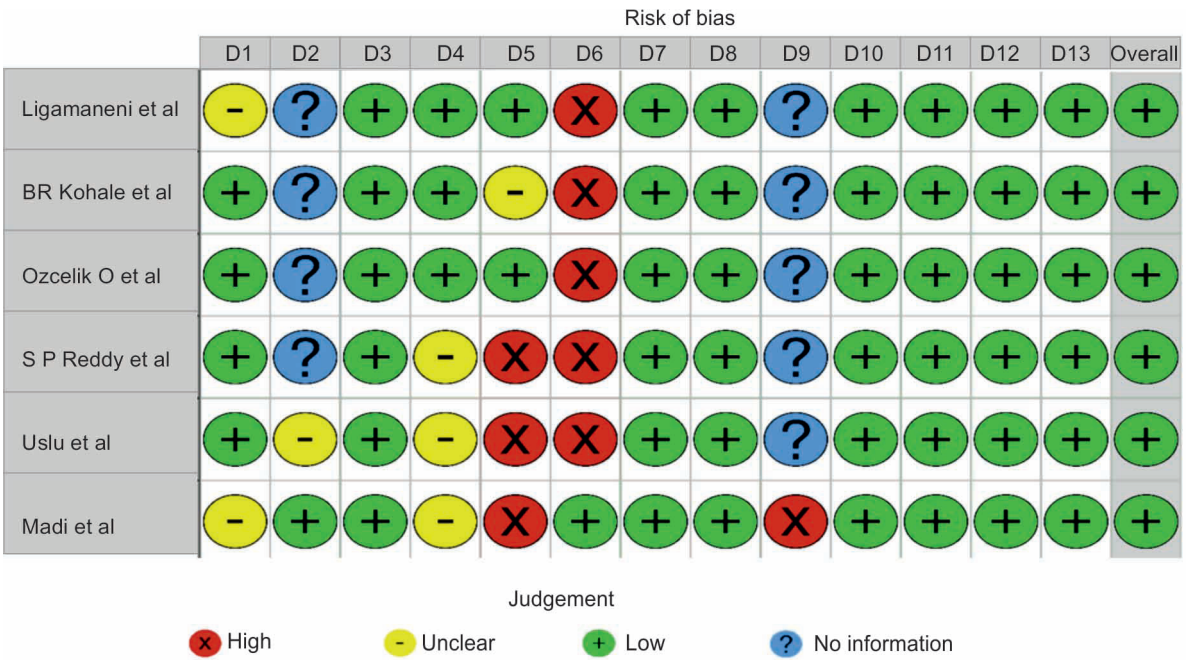

Fig. 2: Traffic light plot for RoB for RCTs; D1: was true randomization used for assignment of participants to treatment groups; D2: concealment of allocation to treatment groups; D3: groups similar at baseline; D4: blinding of participants; D5: blinding of treatment providers; D6: blinding of outcome assessors; D7: treatment of groups identically other than intervention of interest; D8: follow-up; D9: analyzing participants in the group to which they were randomized; D10: measurement of outcomes; D11: reliability of outcome measurement; D12: usage of appropriate statistics; D13: appropriateness of trial design and deviations from standard RCT

to deal with the confounders were NR in both studies.[5,16] Assessment of outcomes was done in a valid and reliable manner in both studies.[5,16] The period of exposure to be meaningful was NA for both studies.[5,16] An appropriate statistical method to analyze the results was used in both studies, and the overall RoB was low in both studies (Table 5) (Fig. 3).[5,16]

Discussion

The present study was based on a systematic review of RCTs and case-control studies that evaluated the role of PBM in the management of wound healing following gingivectomy. A vigilant analysis of the pertinent studies showed that six RCTs[6,17–21] and two case-control studies,[5,16] with varying results, addressed the focused question. Within the limitations of this systematic review, seven studies[5,6,17–19,21,23] showed that PBM is effective in gingival wound healing and reduction of postsurgical pain, while one study[16] concluded that PBM did not accelerate wound healing following gingivectomy.

The process by which PBM accelerates wound healing is by the stimulation of cellular mitochondria to increase the production of adenosine triphosphate, which in turn increases the reactive oxygen and finally influences redox signaling affecting intercellular homeostasis and proliferation of cells.[24] PBM reduces edema by promoting cellular redox reaction, and it has an effect on microcirculation by changing capillary hydrostatic pressure.[25] In a study by Aoki et al., it was concluded that low-level lasers or light-emitting diodes are important tools for the activation of tissues or cells.[10] The studies included in this review used different wavelengths (580–980 nm), power (50–300 MW), and duration of laser application (40–300 seconds) while most of them did not report detailed laser parameters. More specifically, three studies reported spot size,[6,18,21] two studies reported radiation energy,[6,21] and only two studies reported the number of points irradiated.[6,21] One research group used 588 nm, which falls below the range of low-level lasers, and reported positive results of LLLT, such as the promotion of epithelization and wound healing.[19] On the other hand, a different research group used 670 nm of wavelength and reported that PBM did not improve wound healing.[16] Whereas PBM with a diode laser did not improve wound healing after gingivoplasty both clinically and histomorphometrically.[26]

The systematic review of the available literature suggests that PBM may be a useful tool in the wound healing process and reduction of pain postsurgically; however, the authors perceive that this conclusion is perfunctory due to several drawbacks observed in the included studies. First, the lack of consistency in the methodology used and the missing laser data can significantly affect the reported outcomes, and this remains a priority for future research. Second, the fact that none of the research groups performed a power analysis that could determine an adequate sample size is a potential means of conflicting clinical outcomes. Finally, the different assessments of wound healing, in addition to the overall low number of available studies, represent major parameters that can limit the data interpretation. Overall, seven of the included studies concluded PBM helps in wound healing following gingivectomy, but the heterogeneity of the included studies was high. Therefore, additional studies that analyze the performance of PBM in wound healing are recommended. These should preferably comprise well-controlled randomized clinical trials with a split-mouth design and follow the CONSORT statement recommendations to minimize and control the RoB and confounding factors. Furthermore, a standardized protocol should be performed with uniform settings and adequate sample size. Due to the heterogeneity of the included studies, definitive

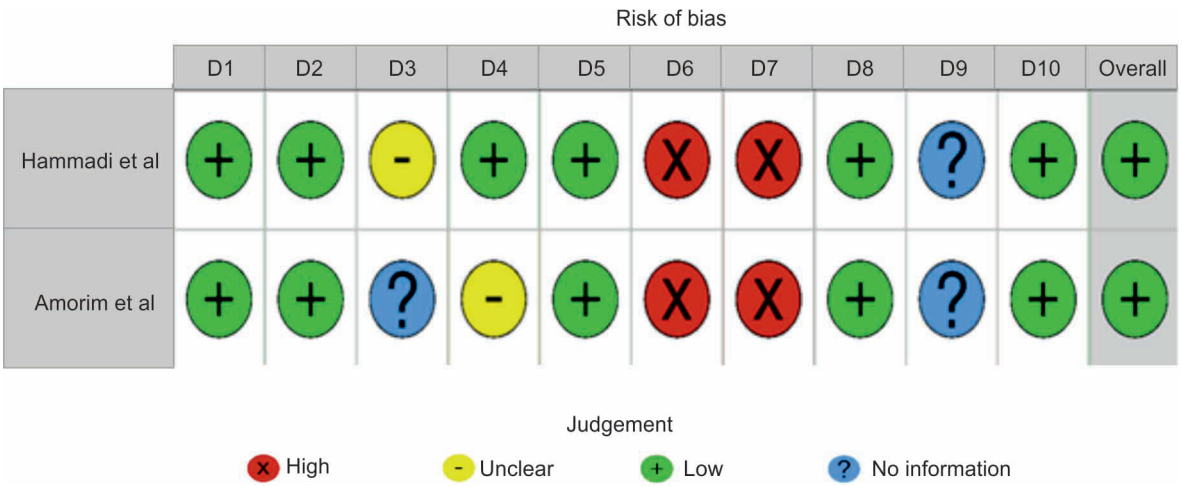

Fig. 3: Traffic light plot for RoB for case control studies; D1: comparability of groups other than the presence of absence of the condition; D2: matching of cases and controls; D3: criteria used for identification of cases and controls; D4: measurement of exposure; D5: measurement of exposure same for cases and controls.; D6: identification of confounding variables; D7: strategies to deal confounding variables; D8: measurement of outcomes in standard reliable way for both the groups; D9: exposure period long enough to be meaningful; D10: usage of appropriate statistic

Table 5: Joanna Briggs RoB tool for case-control studies

Author	*Year*	*Type of study*	*Q1*	*Q2*	*Q3*	*Q4*	*Q5*	*Q6*	*Q7*	*Q8*	*Q9*	*Q10*	*Total*
16	2013	Case-control study	Yes	Yes	UC	Yes	Yes	No	No	Yes	NA	Yes	66.60
5	2006	Case-control study	Yes	Yes	NA	UC	Yes	No	No	Yes	NA	Yes	62.50

UC, unclear; NA, not applicable

conclusions cannot be drawn, but the overall review supports PBM as an adjunct therapy tool that may enhance wound healing following gingivectomy.

Conclusion

Overall, the review supports PBM as an adjunctive tool for the promotion of wound healing following gingivectomy. The overall RoB was low in the included studies, further power-adjusted, and well-designed RCTs with long-term follow-up are needed.

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