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"PHOTOBIOMODULATION THERAPY AS AN ADJUNCT TO GINGIVAL GRAFT FOR THE MANAGEMENT OF GINGIVAL RECESSION - A SYSTEMATIC REVIEW AND META-ANALYSIS"

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Gingival recession, subepithelial connective tissue graft, low-level laser therapy, wound healing, periodontology, tissue repair, wound, tissue effect

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ABSTRACT

BACKGROUND: This study aimed to systematically evaluate the effectiveness of photobiomodulation therapy as an adjunct to gingival grafting technique in the management of patients with gingival recession defects.

METHODS: A comprehensive literature review was performed, including PubMed and the Cochrane Library, published up to and including December 2023. There were no restrictions on the date of publication. Articles available in English were included. Using the Cochrane Collaboration tool, we assessed the risk of bias for randomized controlled trials. A meta-analysis was performed on the relevant studies.

RESULTS: Twelve randomized controlled trial were included. The standardized mean difference for Gingival recession depth between both the groups favored the PBMT+GG group showing a statistically significant difference (SMD, -0.81, 95% CI = -1.38 - -0.24, p – 0.005, I2- 75%). Standardized mean difference for width of keratinized tissue between both the groups showed a statistically significant difference between the groups (SMD, 0.47, 95% CI = -0.07 - 1.00, p – 0.09, I2- 77%) favoring the PBMT+GG group. The standardized mean difference for probing depth between both the groups favored the PBMT+GG group but did not show statistically significant difference (SMD, -0.08, 95% CI = -0.32 - 0.15, p – 0.49, I2- 0%). The standardized mean difference for clinical attachment loss between both the groups favored the PBMT+GG group showing a statistically significant difference (SMD, -0.63, 95% CI = -1.08 - -0.17, p – 0.007, I2- 78%). the standardized mean difference for post-operative pain between both the groups favored the PBMT+GG group showing a statistically significant difference (SMD, -1.29, 95% CI = -2.23 - -0.36, p – 0.007, I2- 91%).

CONCLUSION: We concluded that the present systematic review can contribute to answering questions about the effectiveness of Photo biomodulation therapy on periodontal soft tissues during surgical procedures, considering the limitations we found that photo biomodulation therapy showed additional benefit in the long term when associated with connective tissue graft in the treatment of Miller Class I and II gingival recessions, also it improves the rate of wound healing and patient comfort in the immediate post-operative period. However, care must be used when interpreting the findings of this systematic review because of the small number of included studies and considerable heterogeneity in the laser parameters. Thus, more studies are needed to obtain more conclusive feedback.

INTRODUCTION

Gingival recession (GR), defined as the apical migration of the gingival margin beyond the cementoenamel junction, results in root exposure and leads to hypersensitivity, root caries, and aesthetic concerns (4–6). Predisposing factors for GR include a thin gingival biotype, buccal prominence of teeth, lack of keratinized tissue, high frenal attachment, persistent inflammation, and vigorous brushing (7). Various periodontal plastic surgery (PPS) techniques—such as guided tissue regeneration, connective tissue grafts (CTGs), periosteal pedicle graft (PPG), coronally advanced flap (CAF), and acellular dermal matrix allograft (ADMA)—are used to manage GR (8).

Studies suggest that combining CTG with low-level laser therapy (LLLT) may improve root coverage outcomes (9). PPG has also been proposed as an effective option for root coverage, with LLLT providing additional stabilization (10). The CAF technique is widely considered predictable and relatively simple, though combining it with CTG improves success but requires a second surgical site, increasing postoperative discomfort (11–14).

New therapeutic strategies such as photobiomodulation offer potential benefits by accelerating wound healing and enhancing surgical outcomes (15). LLLT, using infrared light (660–980 nm, 0.05–0.5 watts), stimulates mitochondria, increasing ATP production and improving healing processes (16–17). Studies indicate that LLLT promotes neovascularization, reduces postoperative discomfort, and enhances collagen synthesis, improving root coverage (15, 20).

Research shows that LLLT supports keratinocyte motility, fibroblast proliferation, and tissue neovascularization, which strengthen gingival flap margins and reduce recession (21, 22). This systematic review aims to address whether photobiomodulation therapy as an adjunct to gingival grafting offers superior outcomes compared to grafting alone in managing gingival recession defects.

AIM: The aim of this study was to systematically evaluate the effectiveness of Photo biomodulation therapy as an adjunct to gingival grafting technique in the management of patients with gingival recession defects.

OBJECTIVES:

1) To compare and evaluate the efficacy of Photo biomodulation therapy as an adjunct to gingival grafting technique.

MATERIALS AND METHODS:

Protocol and Registration

The National Institute for Health Research PROSPERO International Prospective Register of Systematic Reviews approved this systematic review (registration number: CRD42023452481). The protocol followed the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) 2020 guidelines (Page et al., 2021).

Search Strategy

A systematic search was conducted in databases such as Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, CINAHL, EMBASE, PsycINFO, Scopus, ERIC, and ScienceDirect using MeSH terms, text words, and Boolean operators. Articles in English or those with potential for English translation were considered, covering publications from January 1, 2010, to June 30, 2023. Additional literature searches were performed using PubMed, Cochrane, and Google Scholar up to December 2021. Articles were screened by two independent reviewers according to predefined eligibility criteria, with disagreements resolved through a third reviewer.

Eligibility Criteria

Inclusion Criteria

- Population (P): Patients with localized or multiple recession-type defects, classified as Miller Class I or II, irrespective of demographic characteristics.
- Intervention (I): Photobiomodulation (PBM) or low-level laser therapy (LLLT) combined with gingival grafts.
- Comparison (C): Gingival grafts alone.
- Outcome (O): Primary outcomes include gingival recession depth (GRD), width, probing depth, clinical attachment level, keratinized tissue width, and thickness. Secondary outcomes assess plaque index, gingival index, bleeding on probing, postoperative pain, clinical healing, wound healing index, mean root coverage, and complete root coverage.
- Study Design (S): Randomized controlled trials (RCTs).

Exclusion Criteria

- Participants with significant medical conditions or medication use that may affect outcomes.
- Studies using other treatment combinations besides PBM with gingival grafts.
- Single-intervention trials without control groups.
- Observational studies, case reports, case series, cross-sectional studies, and reviews.
- Studies with only abstracts or unavailable full texts.

Screening and Selection of Studies

Two reviewers independently screened titles, abstracts, and full texts, with duplicate records removed using software. Cohen's kappa values were 0.90 for titles and abstracts, and 0.92 for full texts. Discrepancies were resolved by a third reviewer through discussion.

Data Extraction

A standardized data extraction form was developed using Microsoft Excel (2013). After piloting on two articles, data extraction proceeded under categories such as author, year, study design, sample size, intervention, comparison, outcomes, and conclusions.

Statistical Analysis for Quantitative Synthesis

Review Manager (RevMan) 5.3 was used for statistical analysis. Results were presented as mean and standard deviation for continuous data, with 95% confidence intervals (CIs) and $p < 0.05$ considered significant. Heterogeneity was assessed using the Chi-square, Tau-square, and I^2 tests, applying a random-effects model if $I^2 > 50\%$. Subgroup analysis addressed clinical heterogeneity, and funnel plots were used to detect publication bias when more than 10 studies were available for each outcome.

Literature Search

The literature search included PubMed, MEDLINE, DOAJ, the Cochrane Library, and Scopus, supplemented by Google Scholar, Greylist, OpenGrey, and hand searches. Relevant MeSH terms and free text terms were combined using Boolean operators (OR, AND) following the PICOS framework (Table 1).

Study Characteristics

Twelve randomized controlled trials (RCTs) were included, conducted across Brazil (3 studies), India (5 studies), Turkey (3 studies), and the USA (1 study). The participants, aged 18–55 years, included 404 individuals (206 in the intervention group and 198 in the control group). Most studies classified gingival recession as Cairo RT or Miller Class I or II. Various lasers were employed, including aluminum gallium arsenide diode lasers and diode lasers. The studies concluded that PBM/LLLT offered additional benefits when used with connective tissue grafts for Miller Class I and II recessions (Table 2, Table 3)

Figure 1. Flowchart of Selection of studies

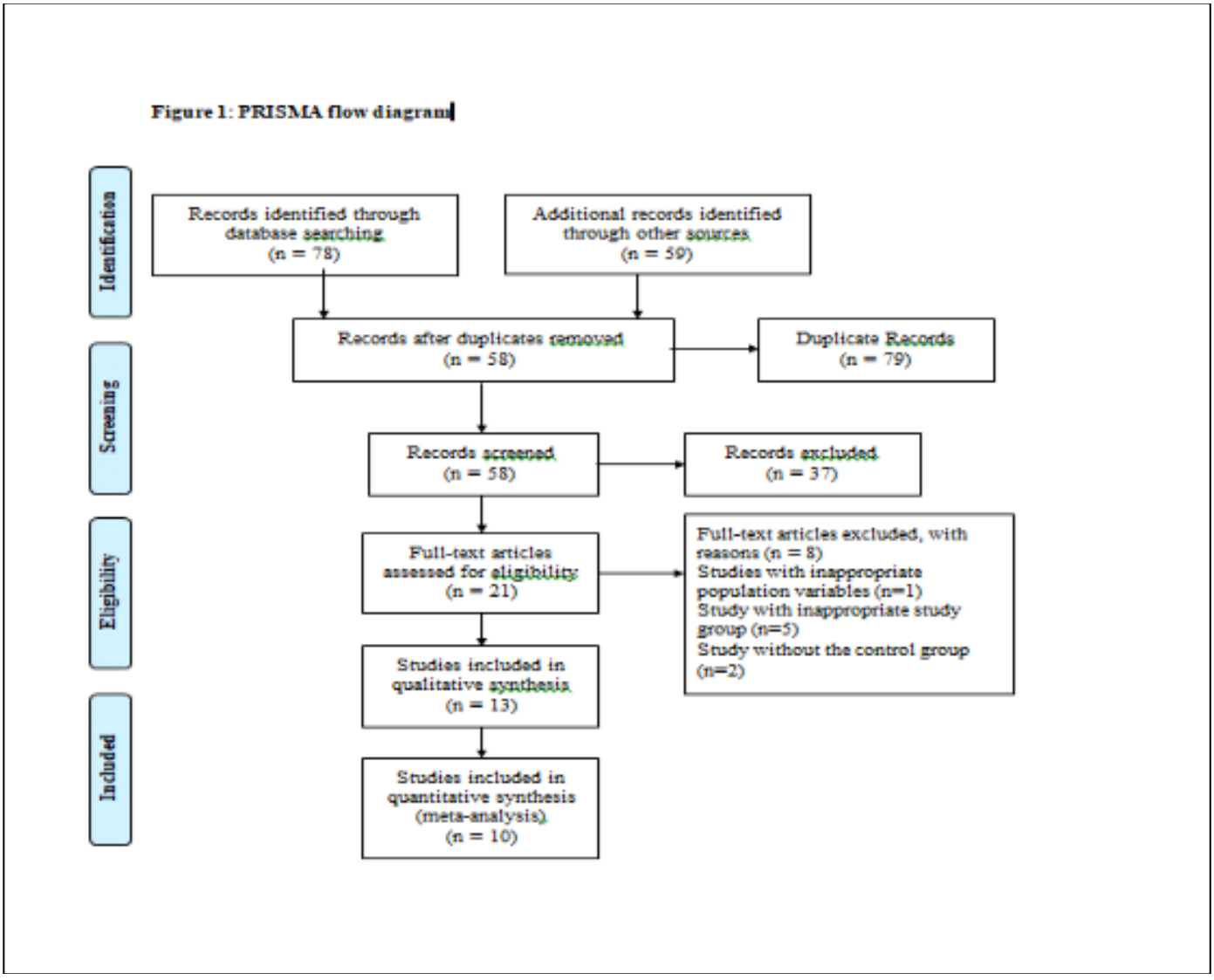
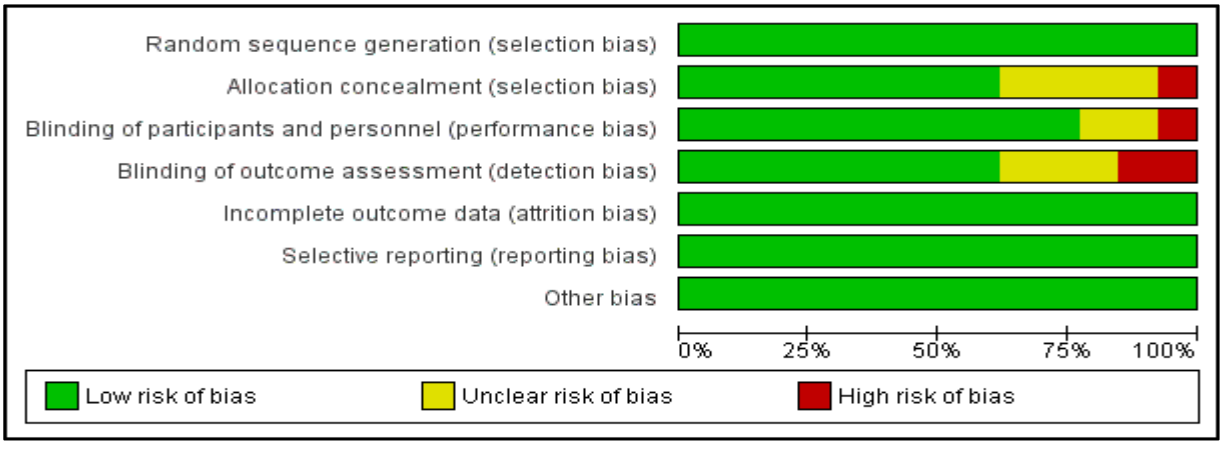
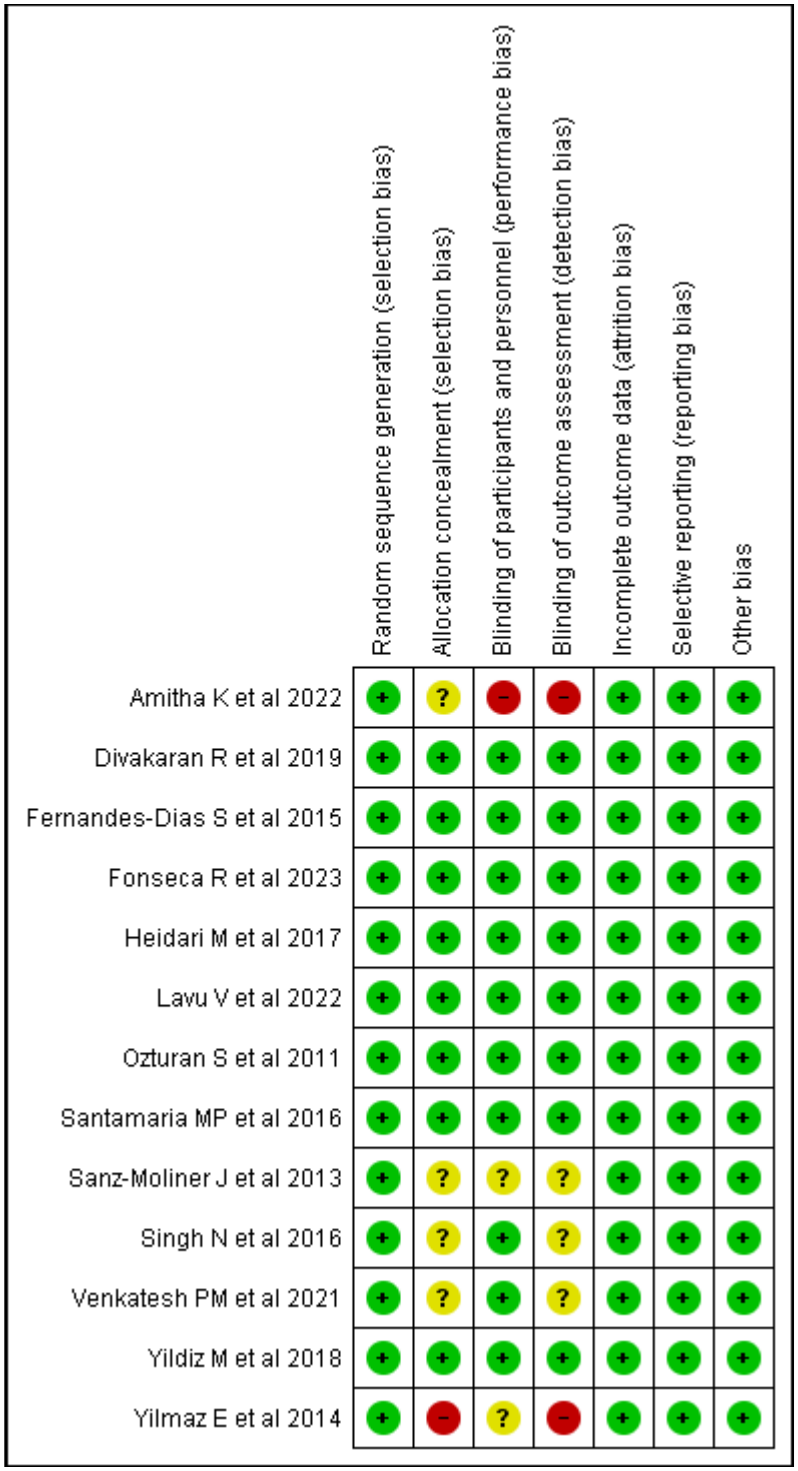


Figure 2. A Risk of bias graph



B, Risk of bias summary



Study Characteristics:

Study Id	Place of study	Study Design	Sample Size I/C	Age group I/C (years)	Teeth with recession	Type of recession	Type of flap	Intervention group	Control group	Laser Technique	Type of laser	Wavelength/ Power/ Density	Mode	Time of LLLT application	Time interval	Primary Outcomes	Secondary Outcomes	Authors Conclusions

Fonseca R et al 2023	Brazil	RCT	3/3	35	Maxillary canines and both premolars	Cairo RT I or Miller Class I or II	Coronal sliding flap	aCTG + LLLT	aCTG	Slightly safe distance from the gingival tissue at a perpendicular angle due to blood or fluid contact to prevent the contamination of the laser tip	GaAlAs diode laser	660 nm/30 mW/15 J/cm2	Continuous wave mode for 4 s 4 times	1st - Preoperative period on the buccal region 2nd - After evaluation 3rd - After removing aCTG from the hard palate and before suturing it in the buccal periodontal periosteum 4th - Immediate postoperative period 5th - Postoperative recovery	BL, 3M	PD, CAL, KTW, KTT	Post-operative Pain, PI, BoP	Results indicated that aCTG + LLLT might have an additional benefit to GR root coverage within the evaluated time
Amitha K et al 2022	India	RCT	15/15	20-55		Miller's Class I or Class II recession	modified coronally advanced flap (MCAF)	MCAF + LLLT	MCAF + Sham	5 min daily for 5 days irradiation with a low-level laser to the adjacent surgical area and the inner surface of the mobilized MCAF before closure and immediately after flap closure	Diode (GaAlAs)	810 nm/120 mW	Continuous mode for 5 mins	1st- Before suturing 2nd- Soon after closure of the flap in each test site for 5 min 3rd- post-operatively for 5 days	BL, 3M, 6M	GRD, GRW, KTW, PD	WHI	Adjunctive usage of lasers, along with the MCAF technique showed predictable, sustainable root coverage and overall, a fairly satisfactory healing response.

Lavu V et al 2022	India	RCT	14/19	20-45	maxillary / mandibular isolated gingival recessions	Presence of isolated (single tooth) Cairo's RT1	Laterally closed tunnel technique (LCT)	LCT + PBMT	LCT + Sham	Perpendicular to the tissue in light contact with the wound site with a light guide tip with a beam diameter of 3 mm and area of 0.07 cm2	diode laser	660 nm/50mw/-		1st- On day of surgery 2nd- Third day 3rd- Seventh day 4th- Tenth day post-surgery	3, 7, 10, 14 D, 1M, 3M, 6M	GRD, GRW, PD, CAL, KTW	WHI	Adjunctive use of photobiomodulation did not show a better outcome concerning recession depth but appears to provide faster healing of the surgical wounds and better patient comfort.
Venkatesh PM et al 2021	India	RCT	7 per group	20-50	Maxillary or mandibular arches	Millers class I and II or combined class I and II recession defects in	Periosteal pedicle flap	PPG + LLLT	PPG + sham	Tip of the laser probe was placed perpendicularly in contact mode for 5 minutes at each session	diode low intensity laser	810 nm/120 mW	Continuous mode for 5 minutes	1st- Before suturing 2nd- Immediately after flap closure 3rd- Post operatively for 5 minutes daily for 5 days	3W, 3 M, 6 M	GRD, GRW, PD, CAL, WKT	PI, GI, GBI, WHI	At the end of six months in the current clinical trial, post-surgical evaluation revealed that PPG can be an excellent alternative for root coverage procedures and the use of LLLT may stabilise the root coverage obtained by PPG.

Divakaran R et al 2019	India	RCT	15/15	34-48	maxillary or mandibular canines or premolars	Miller's Class I/II gingival recession defects	Coronally advanced flap with subepithelial connective tissue graft (CAF + SCTG)	CAF + SCTG + LLLT	CAF + SCTG + Sham	Laser irradiation was directed from the coronal to the apical aspect in parallel direction along the inner surface of the flap aimed at a 45° angle without contacting the root surface or alveolar bone and also on the outer surface of the flap for 30-s interruption in the laser emission when the irradiation exceeded 10 s and not exceeding a total dosage of 4J/cm 2	Gallium-aluminium-arsenide diode laser	810 nm/1.5 watt/-	Continuous mode	1st-Before Flap 2nd-Post suturing once every 15 days for the first 4 weeks	BL, 6 W, 3 M, 6 M	GRW, KTW, PD,	WHI, MRC, CRC	Generalized reduction in GRD from baseline to 6 months in both the groups. The MRC and CRC were similar in both the groups.
Yildiz M et al 2018	Turkey	RCT	15/15	20-40	Vital incisors	Class I or II Miller gingival recession	Split thickness flap	FGG + LLLT	FGG + sham	Directed perpendicularly toward the tissue in the noncontact mode	diode laser	810nm/0.1W/6 J/cm 2	Continuous wave mode (spot size 0.5 cm) for 60s	1st-Immediately after surgery and 1, 3, 7, and 14 days later	Daily for 1 W		Post-operative pain	The use of an 810-nm diode laser provided additional benefits to FGG in terms

																		of less shrinkage of the graft dimensions and postoperative pain.
Heidari M et al 2017	Iran	RCT	12/12	40.2 ± 9.2	Mandibular teeth, bilaterally mesial aspect of first premolar to distal aspect of first molar			FGG + LLLT	FGG + sham	Directed perpendicularly with slight contact with the tissue	Diode laser	660 nm/200 mW/32 J/cm2	Continuous mode for 4s per point	1st- After surgery 2nd- 1, 2, 4 and 7 days later	1, 2, 7, 14, 21, 30, 45 D		Clinical Healing Postoperative Pain	PBMT following FGG procedure with the parameters used in this study could accelerate the rate of epithelialization at the donor site. It did not reduce postoperative pain
Santamaria MP et al 2016	Brazil	RCT	19/17	Older than 18 years	Maxillary canines or premolars	Miller class I or II gingival recession	Trapezoidal coronally advanced flap	CTG + LLLT	CTG + Sham laser	The tip of the laser device was placed, with slight contact, on the gingival tissue.	GaAlAs diode laser	660 nm/30 mW/15 J/cm2	Continuous wave mode for 4 seconds per point	1st- Just after sutures 2nd- Followed by every-other-day applications for 2 weeks	BL, 6M, 12 M, 24 M	PD, CAL, RGR, GR, KWT, KTT	PI, FMBI, BOP	The results indicated that LLLT showed no additional benefit in the long term when associated with connective tissue graft in the treatment of Miller Class I and II gingival recessions
Singh N et al 2016	India	RCT	20/20	21 - 36	Maxillary right and left central incisors		Semilunar coronally advanced flap	SCAF + LLLT	SCAF	Non-contact mode (from 1 cm distance)	GaAlAs diode laser (810 nm).	810 nm/0.3 watts / 4 J/cm2	Continuous wave for 10 seconds	1st- On the day of surgery and 2nd- On 7th day post-operatively	BL, 6M	GRD, GRW, PD, CAL, WKT		The results depicted that a LLLT application may enhance the predictability

																		of SCAF procedure.
Fernandes-Dias S et al 2015	Brazil	RCT	20/20	Older than 18 years	Maxillary buccal gingival recessions in their canines and premolars	Miller Class I or II gingival recession		Connective tissue graft (CTG) + LLLT	CTG + Sham	Applications were performed using punctual contact with the tip perpendicular to the gingival tissue.	GaAlAs diode laser	660 nm/30 mW/15 J/cm2	Continuous mode4 s per point	1st-Immediate postoperative period 2nd-Followed by seven more applications performed every other day	BL 3M 6M	PD, CAL, KTT, KTW,		Low-level laser therapy may increase the percentage of complete root coverage when associated with CTG
Yilmaz E et al 2014	Turkey	RCT	16/15	25-39	Lower incisors	Miller II gingival recession	Laterally positioned flap	LPF + LLLT	LPF	An external horizontal releasing incision on the vestibular alveolar mucosa was made with diode laser along with de-epithelialization of the interdental papilla.	Diode laser	810 nm/3 W	Continuous mode	1st-Laser incision 2nd-De-epithelialization of the interdental papilla	BL, 6M	GRD, GRW, PD, CAL, KTW	MRC, CRC	Six month results showed that the LALPF approach was effective for the treatment of single Miller class II gingival recessions.
Sanz-Moliner J et al 2013	USA	RCT	13/13	48(8.5)	Posterior anterior tooth with one site		Modified Widman flap	MWF + LLLT	MWF + Sham	45-degree angle to the soft-tissue flap and avoiding contact to the root surface or the alveolar bone by placing a periosteal retractor between the hard	Aluminium, gallium, and arsenide diode laser	810 nm/1 W/ 4 J/cm2	Continuous mode	1st-Removal of all visible epithelium in the inner side of the flap 2nd-Before suturing	Daily for 1 W		Postoperative pain	The use of an 810-nm diode laser provided additional benefits to MWF surgery in terms of less edema and postoperative pain

										and soft tissue								
Oztu ran S et al 2011	Tu rk ey	RC T	37 /3 7	Me an ag e 34	Six cent ral incis ors, four later al incis ors, 14 cuspi ds, eight -first pre-mola rs and 5 s pre-mola rs	Mill er clas s I or II ging ival rece ssio ns	Coro nally adva nced flap	CAF + LILT	CA F + Sha m	During irradia tion, the tip of the laser probe was placed perpen dicular ly with slight contac t on the area.	Diod e laser	588n m/12 0 mW/ 4.0 J/cm 2	Cont inuo us wave mod e for 5 min	1st- Before flap closure 2nd- Immed iately after flap closure 3rd- post-operati vely daily for 7 days	BL, 1Y	GRD , GRW , PD, CAL, KTW		The use of LLLT may increas e the succes s of CAF operati ons and result in more stable outco me

Statistical analysis

Figure 3- Gingival recession depth- Forest plot

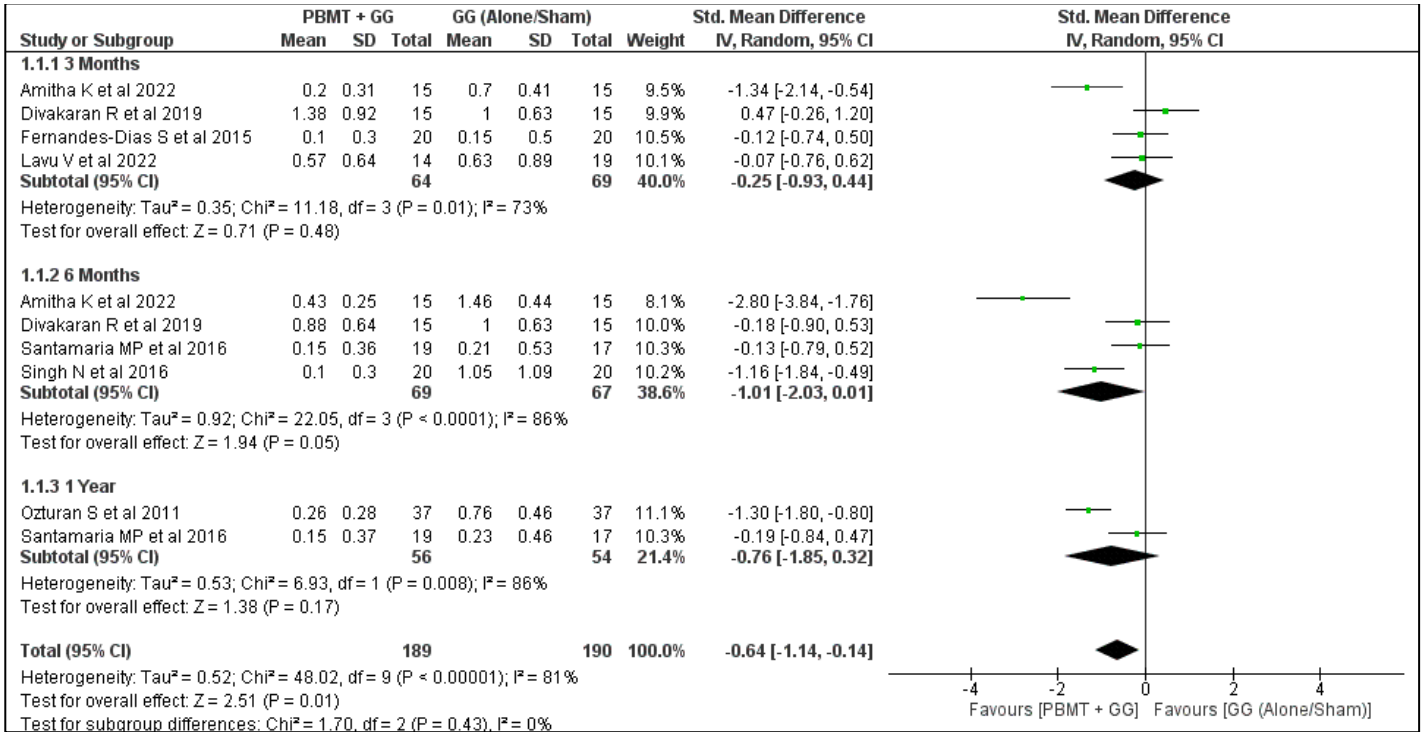


Figure 4- Gingival recession width- Forest plot

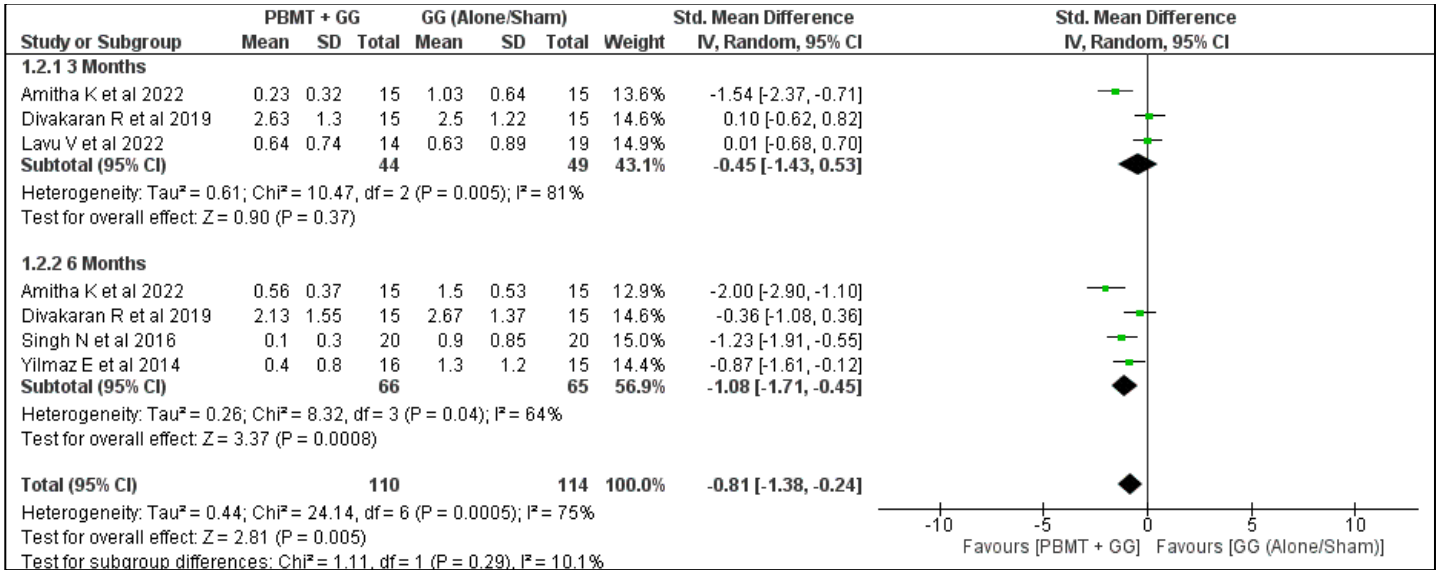


Figure 5- WKT- Forest plot

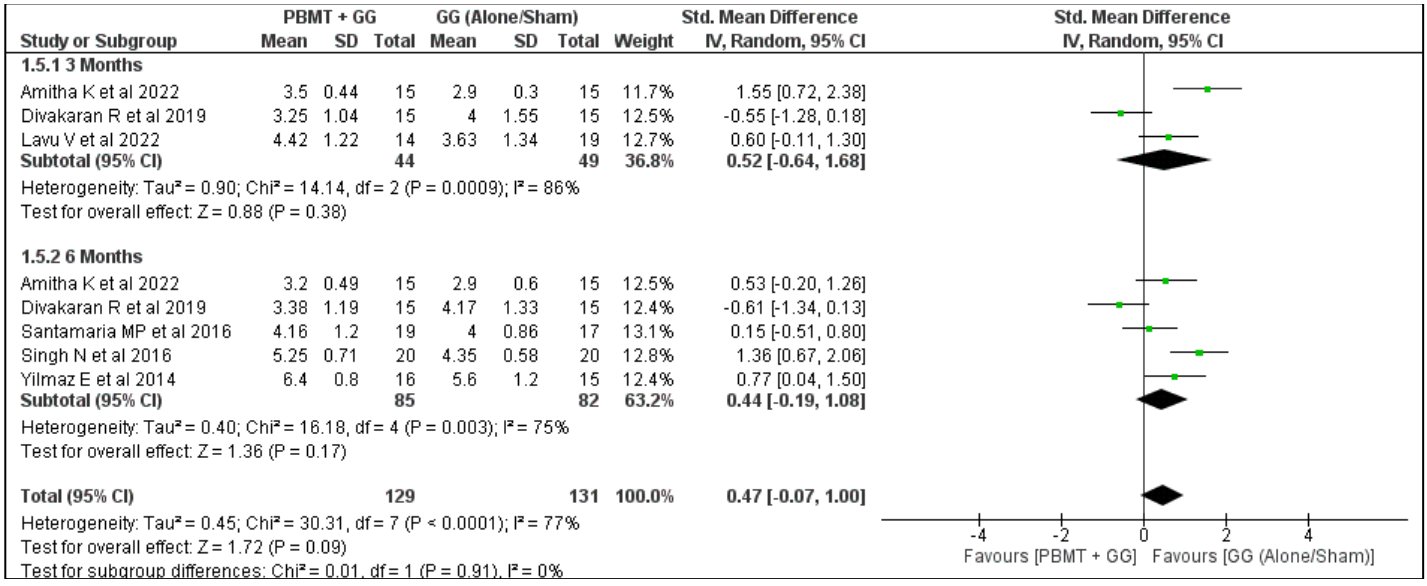


Figure 6- PD- Forest plot

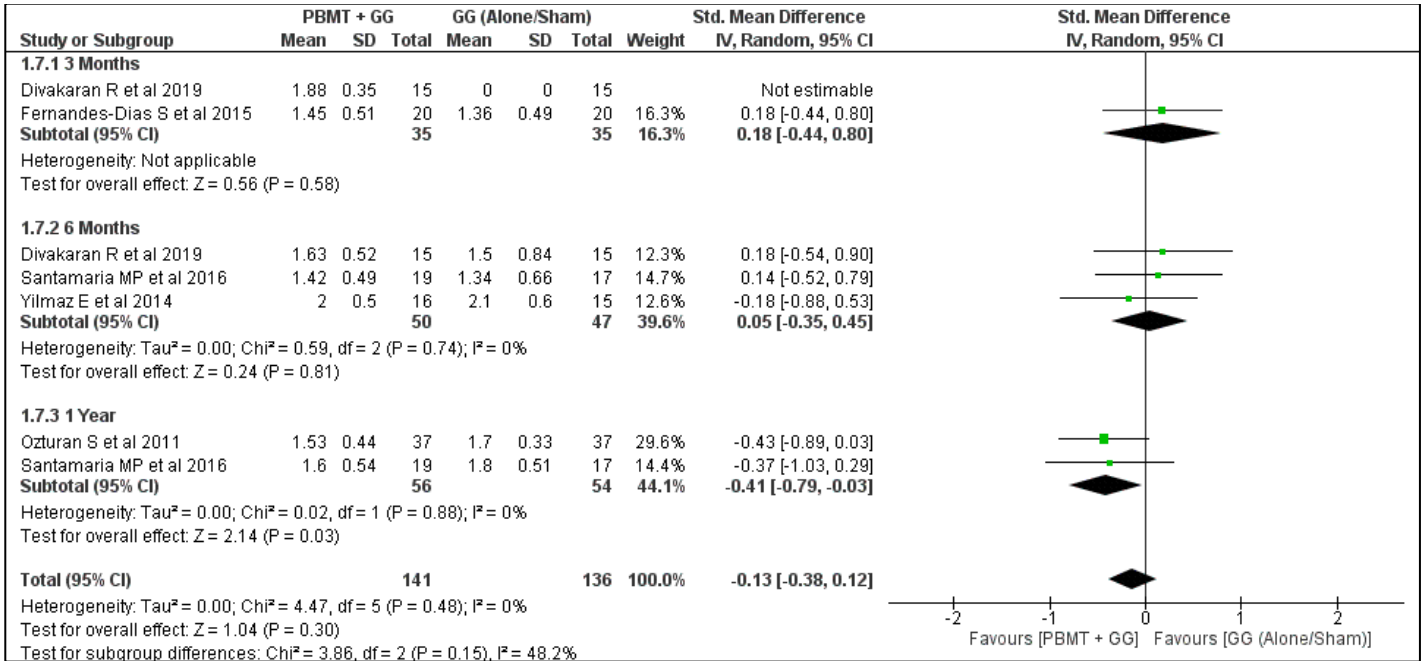


Figure 7- CAL.- Forest plot

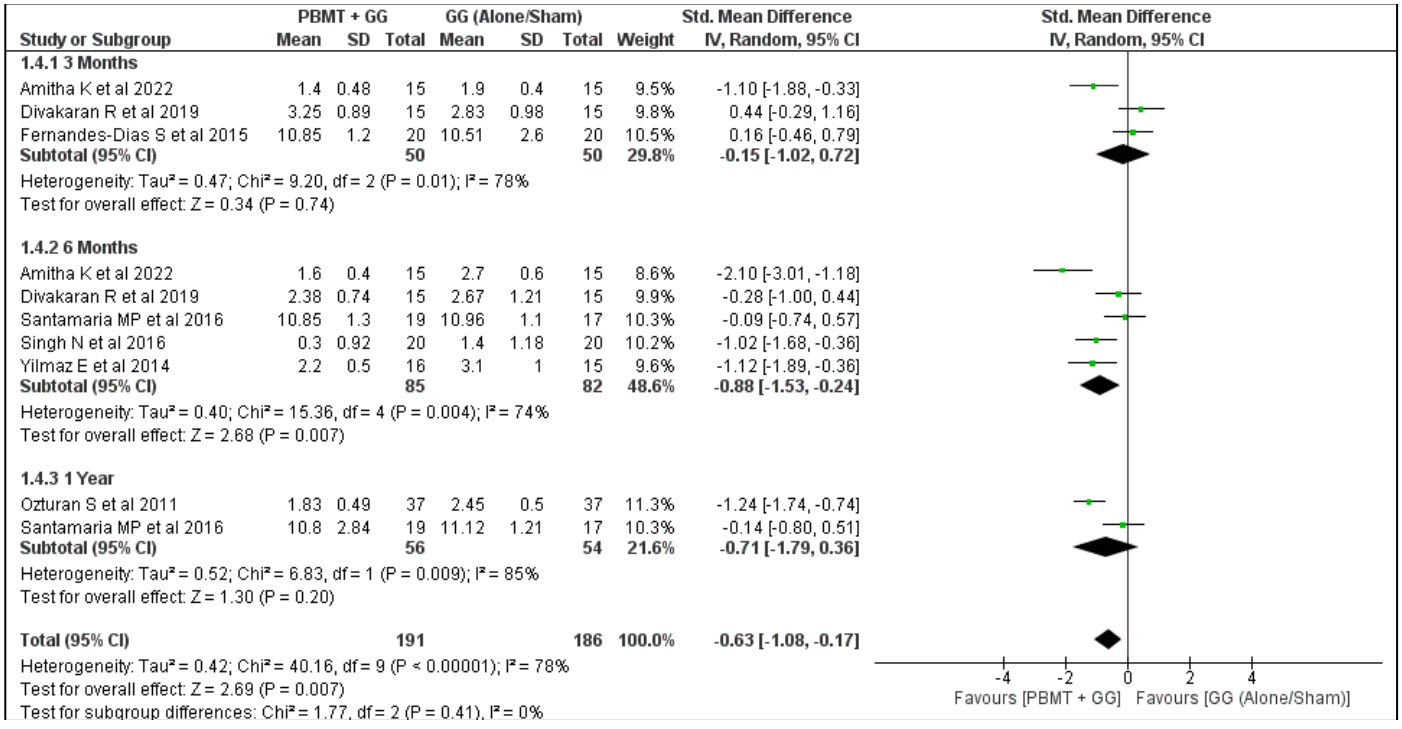


Figure 8- Post-operative pain- Forest plot

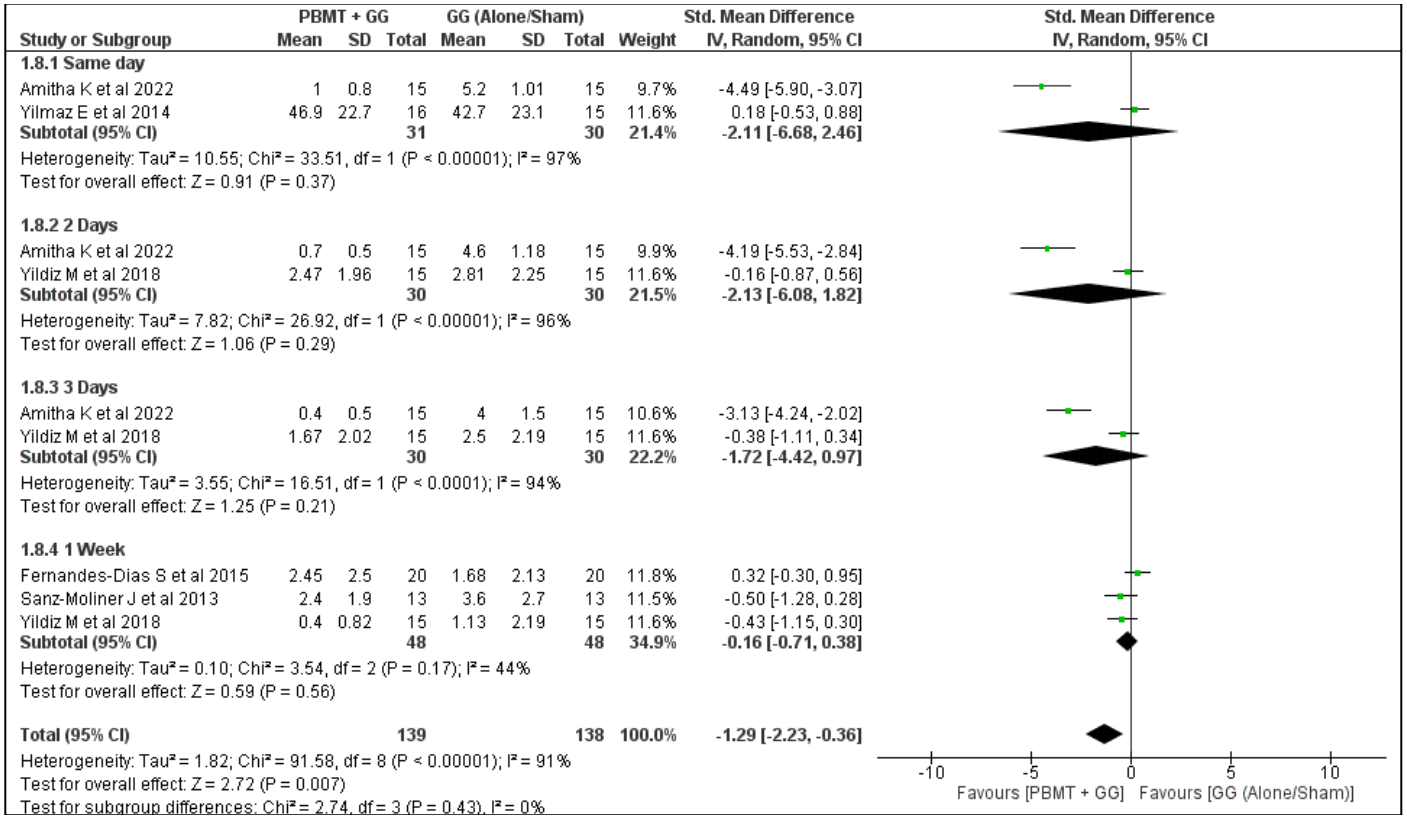


Table 3: Outcome measures assessed in Individual Studies

Study Id	Sample Size Intervention/Control	Intervention	Control
Gingival recession depth			
Amitha K et al 2022	15/15	BL 3.33 (0.90) 3M 0.20 (0.31) 6M 0.43 (0.25)	BL 3.23 (0.94) 3 M 0.70 (0.41) 6M 1.46 (0.44)
Lavu V et al 2022	14/19	3M 0.571 (0.646)	3M 0.632 (0.895)
Divakaran R et al 2019	15/15	BL 2.00(0.76) 3M 1.38(0.92) 6M 0.88(0.64)	BL 2.00(0.00) 3M 1.00(0.63) 6M 1.00(0.63)

Santamaria MP et al 2016	19/17	BL 3.09(0.67) 6M 0.15(0.36) 1Y 0.15(0.37) 2Y 0.21(0.53)	BL 3.33(0.72) 6M 0.21(0.53) 1Y 0.23(0.46) 2Y 0.26(0.56)
Singh N et al 2016	20/20	BL 2.4 ± 0.503 6M 0.1 ± 0.308	BL 2.45 ± 0.51 6M 1.05 ± 1.099
Fernandes-Dias S et al 2015	20/20	BL 3.09 (0.67) 3M 0.1 (0.30) 6M 0.15(0.36)	BL 3.33(0.72) 3M 0.15 (0.50) 6M 0.21 (0.53)
Gingival recession width			
Amitha K et al 2022	15/15	BL 3.86 (0.71) 3M 0.23 (0.32) 6M 0.56 (0.37)	BL 3.80 (0.75) 3 M 1.03 (0.64) 6M 1.50 (0.53)
Lavu V et al 2022	14/19	3M 0.643 (0.745)	3M 0.632 (0.89)
Divakaran R et al 2019	15/15	BL 3.13(0.64) 3M 2.63(1.30) 6M 2.13(1.55)	BL 3.67(0.52) 3M 2.50(1.22) 6M 2.67(1.37)
Singh N et al 2016	20/20	BL 2.45(0.51) 6M 0.1(0.30)	BL 2.4(0.50) 6M 0.9(0.85)

Yilmaz E et al 2014	16/15	BL 5.0(0.6) 6M 0.4(0.8)	BL 4.7(0.9) 6M 1.3(1.2)
Ozturan S et al 2011	37/37	BL 2.22(0.48) 1Y 0.63(0.77)	BL 2.61(0.27) 1Y 1.13(0.57)
Relative gingival recession			
Santamaria MP et al 2016	19/17	BL 12.28(1.58) 6M 9.43(1.10) 1Y 9.20(1.28) 2Y 9.4(1.29)	BL 12.51(1.21) 6M 9.62(0.94) 1Y 9.32(1.07) 2Y 9.44(1.12)
Fernandes-Dias S et al 2015	20/20	BL 12.28(1.58) 3M 9.40 (1.00) 6M 9.43 (1.10)	BL 12.51(1.21) 3M 9.69(0.93) 6M 9.62 (0.94)
Clinical Attachment Loss			
Amitha K et al 2022	15/15	BL 4.7 (0.9) 3M 1.4 (0.48) 6M 1.6 (0.4)	BL 4.7 (0.9) 3M 1.9(0.4) 6M 2.7(0.6)
Divakaran R et al 2019	15/15	BL 3.63(1.06) 3M 3.25(0.89) 6M 2.38(0.74)	BL 3.33(0.52) 3M 2.83(0.98) 6M 2.67(1.21)

Santamaria MP et al 2016	19/17	BL 13.33(1.58) 6M 10.85(1.3) 1Y 10.80(2.84) 2Y 11.37(1.49)	BL 13.56(3.28) 6M 10.96(1.1) 1Y 11.12(1.21) 2Y 11.44(1.24)
Singh N et al 2016	20/20	BL 4.35 (0.587 6M 0.3 (0.923	BL 4.45 (0.51 6M 1.4 (1.188
Fernandes-Dias S et al 2015	20/20	BL 13.33(1.58) 3M 10.85(1.2) 6M 10.85(1.3)	BL 12.88(3.28) 3M 10.51(2.6) 6M 10.96(1.1)
Yilmaz E et al 2014	16/15	BL 7.0(0.7) 6M 2.2(0.5)	BL 6.9(1.0) 6M 3.1(1.0)
Ozturan S et al 2011	37/37	BL 4.65 (0.50) 1Y 1.83 (0.49)	BL 4.92 (0.56) 1Y 2.45 (0.50)
Keratinized Tissue Width			
Amitha K et al 2022	15/15	BL 2.4 (0.41) 3M 3.5 (0.44) 6M 3.2 (0.49)	BL 2.4 (0.41) 3M 2.9 (0.3) 6M 2.9 (0.6)
Lavu V et al 2022	14/19	3M 4.42 (1.22)	3M 3.632 (1.342)

Divakaran R et al 2019	15/15	BL 3.38(1.19) 3M 3.25(1.04) 6M 3.38(1.19)	BL 4.00(0.89) 3M 4.00(1.55) 6M 4.17(1.33)
Santamaria MP et al 2016	19/17	BL 3.75(1.01) 6M 4.16(1.20) 1Y 3.81(0.83) 2Y 3.76(0.78)	BL 3.31(1.00) 6M 4(0.86) 1Y 3.83(0.85) 2Y 4.05(0.89)
Singh N et al 2016	20/20	BL 4.4 (0.503) 6M 5.25 (0.716)	BL 4.45 (0.51) 6M 4.35 (0.587)
Fernandes-Dias S et al 2015	20/20	BL 3.75(1.01) 6M 4.16(1.20)	BL 3.31(1.00) 6M 4 (0.86)
Yilmaz E et al 2014	16/15	BL 1.5(0.5) 6M 6.4(0.8)	BL 1.5(0.5) 6M 5.6(1.2)
Keratinized Tissue Thickness			
Santamaria MP et al 2016	19/17	BL 1.48(0.40) 6M 2.15(0.35) 1Y 2.10(0.27) 2Y 2.09(0.23)	BL 1.26(0.30) 6M 2.09(0.33) 1Y 2.04(0.34) 2Y 2.1(0.36)
Fernandes-Dias S et al 2015	20/20	BL 1.48(0.40) 6M 2.15(0.35)	BL 1.26(0.30) 6M 2.09(0.33)

Periodontal Depth			
Divakaran R et al 2019	15/15	Baseline 1.75(0.46) 3M 1.88(0.35) 6M 1.63(0.52)	Baseline 1.67(0.82) 3M 1.67(0.82) 6M 1.50(0.84)
Santamaria MP et al 2016	19/17	BL 1.05(0.22) 6M 1.42(0.49) 1Y 1.60(0.54) 2Y 1.97(0.58)	BL 1.05(0.22) 6M 1.34(0.66) 1Y 1.80(0.51) 2Y 2(0.53)
Fernandes-Dias S et al 2015	20/20	BL 1.05(0.22) 3M 1.45(0.51) 6M 1.42(0.49)	BL 1.05(0.22) 3M 1.36(0.49) 6M 1.34(0.66)
Yilmaz E et al 2014	16/15	BL 1.8(0.6) 6M 2.0(0.5)	BL 1.9(0.5) 6M 2.1(0.6)
Ozturan S et al 2011	37/37	Baseline 1.87 (0.29) 1year 1.53 (0.44)	Baseline 1.89 (0.30) 1year 1.70 (0.33)
Post operative pain			
Amitha K et al 2022	15/15	Same Day 1.0 (0.8) 2D 0.7 (0.5) 3D 0.4 (0.5)	Same Day 5.2(1.01) 2D 4.6 (1.18) 3D 4.0 (1.5)
Yildiz M et al 2018	15/15	1D 3.47(2.45) 2D 2.47(1.96) 3D 1.67(2.02) 1W 0.40(0.82)	1D 4.00 (3.01) 2D 2.81 (2.25) 3D 2.50 (2.19) 1W 1.13 (2.19)

Fernandes-Dias S et al 2015	20/20	1W 2.45(2.50)	1W 1.68(2.13)
Yilmaz E et al 2014	16/15	Same Day 46.9(22.7)	Same Day 42.7 (23.1)
Sanz-Moliner J et al 2013	13/13	1W 2.4(1.9)	1 W 3.6(2.7)

Assessments of the Level of Evidence, Risk of Bias, and Quality: The quality of 13 randomized controlled trials (RCTs) was evaluated using the Cochrane ROB tool (Ref 3). Among these, 8 studies were rated as low risk (Ref 9,15,17,20,22,24,25,29), 2 as moderate risk (Ref 10,26), and 3 as high risk (Ref 23,27,28) (Table 3). The moderate and high-risk studies lacked adequate information on random sequence generation, allocation concealment, and blinding of participants, personnel, and outcome assessments (Figure 2a, 2b).

Synthesis of Results:
Ten studies qualified for quantitative analysis, and six meta-analyses with subgroup analyses were conducted. For gingival recession depth, analysis of seven studies (Figure 3) at 3, 6 months, and 1 year showed that although PBMT+GG had a favorable effect, it did not reach statistical significance (SMD at 1 year: -0.76, 95% CI = -1.85–0.32, $p = 0.17$, $I^2 = 86\%$). For gingival recession width (Figure 4), PBMT+GG showed significant improvement at 6 months (SMD = -1.08, 95% CI = -1.71–0.45, $p = 0.008$, $I^2 = 64\%$). Similarly, PBMT+GG demonstrated a statistically significant increase in the width of keratinized tissue (Figure 5) when time points were combined (SMD = 0.47, 95% CI = -0.07–1.00, $p = 0.09$, $I^2 = 77\%$).

Additional Clinical Outcomes:
PBMT+GG showed improvement in probing depth at 1 year (SMD = -0.41, 95% CI = -0.79–0.03, $p = 0.03$, $I^2 = 0\%$) but no significance at earlier intervals (Figure 6). Clinical attachment loss (Figure 7) at 6 months significantly favored PBMT+GG (SMD = -0.88, 95% CI = -1.53–-0.24, $p = 0.007$, $I^2 = 74\%$). Post-operative pain (Figure 8) did not show significant differences on specific days, but overall analysis favored PBMT+GG with statistical significance (SMD = -1.29, 95% CI = -2.23–-0.36, $p = 0.007$, $I^2 = 91\%$). These findings indicate that PBMT+GG may provide clinical benefits in certain parameters compared to GG alone.

DISCUSSION

In this systematic review and meta-analysis, 13 studies were included in the qualitative synthesis and 10 in the quantitative assessment. There is global consensus on mucogingival plastic procedures, indicating that connective tissue grafts (CTG) improve root coverage (RC), especially in Miller Class I, II, or Cairo RT I recessions, which show a 100% chance of RC (de Souza Fonseca). Emerging technologies, such as low-level laser therapy (LLLT), offer opportunities to enhance short- and long-term therapeutic outcomes (9).

This review investigated the effectiveness of autogenous connective tissue grafts (aCTG) with LLLT for gingival recession. Results suggest LLLT improves clinical outcomes, with the LLLT group achieving 100% RC compared to 90–95% in control groups, aligning with studies by Santamaria, Ozturan, and Fernandes-Dias, which reported positive impacts on probing depth (PD) and clinical attachment level (CAL). LLLT's ability to achieve complete root coverage (CRC) aligns with the "creeping attachment" phenomenon, although variability across studies complicates interpretation, and optimal laser dosage remains unclear (Fernandes-Dias, 15).

The PBMT technique using a diode laser at 660 nm demonstrated improved healing and increased keratinized gingiva width, though recession depth remained unchanged at 3 months (Lavu, 17). Long-term outcomes showed that LLLT achieved 91.9% RC at six months compared to 89.48% in controls, although the benefits diminished over two years, suggesting creeping attachment contributed to coverage improvement (Santamaria, 20).

LLLT accelerates healing by promoting fibroblast proliferation, early epithelialization, and granulation tissue formation, leading to better periodontal plastic surgery outcomes (Ozturan, 22). However, the benefits of laser de-epithelialization (LD) remain limited. Trials showed no significant difference between LD combined with CTG and CTG alone, with similar outcomes over six months (Divakaran, 24).

Despite some positive effects, studies revealed variability in patient outcomes, with no significant differences in pain, edema, or cosmetic results between LLLT and control groups (Yildiz, 25). Notably, the SCAF-LLLT combination resulted in 90% total RC compared to 30% with SCAF alone, highlighting LLLT's role in enhancing fibroblast proliferation and angiogenesis (Singh, 26). The Laser-Assisted Lateral Pedicle Flap (LALPF) procedure yielded an 81.2% CRC rate, surpassing conventional techniques and improving gingival recession depth (GRD) and clinical attachment level (CAL) (Yilmaz, 27).

Photobiomodulation therapy (PBMT) using 660 nm lasers enhanced wound healing at donor sites, with full epithelialization by day 21 (Heidari, 29). In vitro research confirmed that LLLT stimulates human gingival fibroblast proliferation, migration, and protein synthesis, further justifying its use in tissue repair (31). While LLLT has shown promise in early healing, its long-term benefits remain questionable due to study heterogeneity (Sanz-Moliner, 28).

Limitations of this review include the inclusion of only English-language studies, small sample sizes, short follow-up periods, and variability in methodologies (9,17). Moreover, heterogeneity in laser protocols and incomplete reporting of laser parameters complicate comparisons. Standardizing LLLT protocols and conducting long-term studies are essential to fully understand the clinical advantages of LLLT in periodontal plastic surgeries. Although LLLT may not significantly enhance CAL, PD, or keratinized tissue thickness (KTT) compared to conventional techniques, it holds potential as an adjunct to root coverage procedures, offering improved healing and postoperative comfort. Further research with consistent parameters is necessary to determine LLLT's full impact on wound healing (28,34).

CONCLUSION

We concluded that the present systematic review can contribute to answering questions about the effectiveness of Photo biomodulation therapy on periodontal soft tissues during surgical procedures, considering the limitations we found that photo biomodulation therapy showed additional benefit in the long term when associated with connective tissue graft in the treatment of Miller Class I and II gingival recessions, also it improves the rate of wound healing and patient comfort in the immediate post-operative period. However, care must be used when interpreting the findings of this systematic review because of the small number of included studies and considerable heterogeneity in the laser parameters. Thus, more studies are needed to obtain more conclusive feedback.

REFERENCES

- Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta analyses: the PRISMA statement. Int J Surg 2010;8(5):336–341. DOI: 1016/j.ijsu.2010.02.007.
- Higgins JPT, Green S, ed., Cochrane Handbook for Systematic Reviews of Interventions, Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from www.handbook.cochrane. org.
- Higgins JP, Altman DG, Gøtzsche PC, et al. The Cochrane collaboration's tool for assessing risk of bias in randomized trials. BMJ 2011;343:d5928. DOI: 10.1136/bmj.d5928.
- American Academy of Periodontology. Glossary of periodontal terms. American Academy of Periodontology (1992).
- Chambrone L, Sukekava F, Araujo MG, et al. Root-coverage proce- dures for the treatment of localized recession-type defects: a Cochrane systematic review. J Periodontol. 2010;81(4):452–478.
- Akram Z, Khawaja NA, Rashid H, Vohra F. Sub-epithelial connective tissue graft and enamel matrix derivative in the management of a localized gingival recession defect: a case report. Saudi J Dent Res. 2016;7(2):147–452.
- Tugnait A and V Clerehugh. "Gingival recession—its significance and management". Journal of Dentistry 29.6 (2001): 381-394.
- Tatakis DN, Chambrone L, Allen EP, et al. Periodontal soft tissue root coverage procedures: a consensus report from the AAP Regeneration Workshop. J Periodontol. 2015;86(2-s):S52–S55.
- de Souza Fonseca RR, Silva CP, de Senna Sastre BL, Tanaka EB, Carvalho TR, de Oliveira PG, de Menezes SA, Laurentino RV, de Oliveira RP, de Oliveira RP, Lago AD. Clinical Evaluation of Bilateral Multiple Gingival Recession Treatment with Autogenous Connective Tissue Graft Associated with Low-Level Laser Therapy. Journal of Clinical Medicine. 2023 Mar 17;12(6):2349.
- Venkatesh PM. Comparison of Recession Coverage Using Periosteal Pedicle Graft Alone and in Combination with Low Level Laser Therapy-A Randomised Controlled Clinical Trial. EC Dental Science. 2021;20:68-80.
- Cairo, F., Pagliaro, U. & Nieri, M. (2008) Treatment of gingival recession with coronally advanced flap procedures: a systematic review.Journal of Clinical Periodontology 35, 136–162.
- Roccuzzo, M., Bunino, M., Needleman, I. & Sanz, M. (2002) Periodontal plastic surgery for treatment of localized gingival recessions: a systematic review. Journal of Clinical Periodontology 29, 178–194.
- Chambrone, L., Chambrone, D., Pustiglioni, F.E., Chambrone, L. A. & Lima, L. A. (2008) Can subepithelial connective tissue grafts be considered the gold standard procedure in the treatment of Miller Class I and II recession-type defects? Journal of Dentistry 36, 659–671.
- Matter, J. (1999) Free gingival grafts for the treatment of gingival recession. A review of some techniques. Journal of Clinical Periodontology 9, 103–114.
- Fernandes-Dias SB, de Marco AC, Santamaria Jr M, Kerbauy WD, Jardini MA, Santamaria MP. Connective tissue graft associated or not with low laser therapy to treat gingival recession: randomized clinical trial. Journal of Clinical Periodontology. 2015 Jan;42(1):54-61.
- Lafzi, A.; Kadkhodazadeh, M.; Mojahedi, S.M.; Amid, R.; Shidfar, S.; Baghani, M.T. The Clinical Evaluation of the Effects of Low-Level Laser Therapy on the Donor and Recipient Sites of the Free Gingival Graft: A Case Series. J. Lasers Med. Sci. 2019,10, 355–360.
- Lavu, V.; Gutknecht, N.; Vasudevan, A.; SK, B.; Hilgers, R.-D.; Franzen, R. Laterally closed tunnel technique with and without adjunctive photobiomodulation therapy for the management of isolated gingival recession—A randomized controlled assessor-blinded clinical trial. Lasers Med. Sci. 2022, 37, 1625–1634.
- Lin, J.C.-Y.; Nevins, M.; Kim, D.M. Laser De-epithelialization of Autogenous Gingival Graft for Root Coverage and Soft Tissue Augmentation Procedures. Int. J. Periodontics Restor. Dent. 2018, 38, 405–411.
- Behdin, S.; Monje, A.; Lin, G.-H.; Edwards, B.; Othman, A.; Wang, H.-L. Effectiveness of Laser Application for Periodontal Surgical Therapy: Systematic Review and Meta-Analysis. J. Periodontol. 2015, 86, 1352–1363.
- Santamaria, M.; Fernandes-Dias, S.B.; Araujo, C.; Neves, F.L.D.S.; Mathias, I.F.; Andere, N.M.R.B.; Jardini, M. 2-Year Assessment of Tissue Biostimulation with Low-Level Laser on the Outcomes of Connective Tissue Graft in the Treatment of Single Gingival Recession: A Randomized Clinical Trial. J. Periodontol. 2017, 88, 320–328.
- Khadra, M., Kasem, N., Lyngstadaas, S. P., Haanaes, H. R. & Mustafa, K. (2005) Laser therapy accelerates initial attachment and subsequent behaviour of human oral fibroblasts cultured on titanium implant material. A scanning electron microscope and histomorphometric analysis. Clinical Oral Implants Research 16,168–175.
- Srimayee Chaudhuri , Rahul Sarkar, Kaynat Parween. Exploring Gingival Overgrowth Due to Epileptic Medication: A Case Report. (2025). *Oral Sphere Journal of Dental and Health Sciences*, *1*(1), 35-40. https://doi.org/10.5281/zenodo.14503050
- Amitha K, Paramashivaiah R, Prabhuji ML, Subramanya AP, Assiry AA, Peeran SW, Fageeh H, Bhavikatti SK, Scardina GA. Clinical Assessment of the Effects of Low-Level Laser Therapy on Coronally Advanced Flap Procedure in the Management of Isolated Gingival Recession. InPhotonics 2022 Dec 2 (Vol. 9, No. 12, p. 932). MDPI.
- Divakaran R, George JP, Jha A, Bhardwaj S, Khanna D. Laser-assisted root coverage procedure in gingival recessions: A randomized controlled clinical study. International Journal of Health & Allied Sciences. 2019 Apr 1;8(2):128-34.
- Yildiz MS, Gunpinar S. Free gingival graft adjunct with low-level laser therapy: a randomized placebo-controlled parallel group study. Clinical oral investigations. 2019 Apr 10;23:1845-54.
- Singh N, Uppoor A, Naik D. Semilunar Coronally Advanced Flap with or without Low Level L aser Therapy in Treatment of Human Maxillary Multiple Adjacent Facial Gingival Recessions: A Clinical Study. Journal of Esthetic and Restorative Dentistry. 2015 Nov;27(6):355-66.
- Yilmaz E, Ozcelik O, Comert M, Ozturan S, Seydaoglu G, Teughels W, Haytac MC. Laser-assisted laterally positioned flap operation: a randomized controlled clinical trial. Photomedicine and laser surgery. 2014 Feb 1;32(2):67-74.
- Sharma, Shweta & Salam, Sajjad & Bahadur, Richa & Galani, Mohit & Sachdeva, Kushagra & Kumari, Anukriti & Kashwani, Ritik. (2024). Dental Curing Light : Sustainability, Environmental and Cancer Responsibility. Acta Scientific Cancer Biology. 8. 4-11. 10.31080/ASCB.2024.08.0491.
- Heidari M, Paknejad M, Jamali R, Nokhbatolfoghahaei H, Fekrazad R, Moslemi N. Effect of laser photobiomodulation on wound healing and postoperative pain following free gingival graft: A split-mouth triple-blind randomized controlled clinical trial. Journal of Photochemistry and Photobiology B: Biology. 2017 Jul 1;172:109-14.

- Kreisler, M.; Christoffers, A.B.; Al-Haj, H.; Willershausen, B.; d'Hoedt, B. Low level 809-nm diode laser-induced in vitro stimulation of the proliferation of human gingival fibroblasts. Lasers Surg. Med. 2002, 305, 365–369.
- Bakshi, P.V.; Setty, S.B.; Kulkarni, M.R. Photobiomodulation of human gingival fibroblasts with diode laser—A systematic review. J. Indian Soc. Periodontol. 2022, 26, 5–12.
- Kumari A, Sawhney H, Kashwani R, Gupta G, Das SJ. Triple antibiotics: A synergistic approach to combating infection. IP Indian J Conserv Endod 2023;8(4):189-192. https://doi.org/10.18231/j.ijce.2023.036
- Garcia, V. G., Macarini, V. C., de Almeida, J. M., Bosco, A. F., Nagata, M. J., Okamoto, T., Longo, M. & Theodoro, L. H. (2012) Influence of low-level laser therapy on wound healing in nicotine-treated animals. Lasers in Surgery and Medicine 27, 437–443.
- Enwemeka, C. S., Parker, J. C., Dowdy, D. S.,Harkness, E. E., Sanford, L. E. & Woodruff,L. D. (2004) The efficacy of low-power lasers in tissue repair and pain control: a meta-analysis study. Photomedicine and Laser Surgery 22, 323–329.