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A Systematic Review: Methods of Gingivectomy for Esthetic Marginal Periodontal Tissue Conditioning

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ABSTRACT

This review compared the prognosis of gingivectomy procedures carried out through a scalpel or alternative techniques. An extensive search was performed in the electronic database. Articles were identified according to inclusion criteria. The extracted data from the selected studies were organized in tables and assessed for risk of bias. Ten clinical trial studies were identified. Nine studies used the laser method for gingivectomy, and only one trial was based on the electrosurgical method. Seven studies were at low risk of bias, and three were at high risk. No significant differences were presented in pain and discomfort in the electrosurgical studies. One study reported non-significant differences between electrosurgery and scalpel regarding clinical healing. Based on limited data in this systematic review, the diode laser showed superiority over the scalpel in pain and discomfort postoperatively. In contrast, for PI and GI, the data were insufficient to conclude the results.

INTRODUCTION

A healthy periodontium should be maintained, especially during tooth restoration, by keeping a safe zone of healthy gingival tissue called "biological width" between the edge of the sub-gingival filling and the bone margin or during the excision of excess gingival tissues for esthetic purposes. The term "biological width" was replaced by "supracrestal attached tissue" in the new classification of periodontal and peri-implant disease and conditions in 2017(Jepsen *et al.*, 2018). It is histologically composed of the junctional epithelium and supracrestal connective tissue attachment. The clinicians can create a healthy supracrestal attached tissue or reposition existing and maintain biological width by gingivectomy, including an apically repositioned flap.

Gingivectomy in crown lengthening procedures is one of the methods proven effective in maintaining the supracrestal tissue attachment intact. It includes removing a pre-determined deep periodontal pocket using a scalpel, electrosurgery, and laser surgery. This systematic review compares the conventional method for gingivectomy (i.e., surgical scalpel) with other methods described for gingivectomy in the literature based on precision cutting, cost-effectiveness, hemostatic function, patient's perception of pain, discomfort during and after the surgery, and periodontal parameters, including PI, GI, and pocket depth (PD).

Methods of Gingivectomy

Surgical Scalpel

The surgical scalpel has been used as a gold standard for many years. Despite the ease of use, cost-effective, precision, and less harmful to the surrounding tissues, bleeding during the surgery obscures the surgical field, and the risk of scalpel injury has been reported. The risk of scalpel injury was about 18% of all sharp injuries, and about 31% of scalpel injuries occurred during direct scalpel use, according to the Exposure Prevention Information Network "EPINet" report in 2003(Perry *et al.*, 2003). To obtain a clear surgical field, the clinician needs a surgical instrument that cuts efficiently like a scalpel, causing less bleeding during the surgery and minimal risk of injury. William Cameron developed this surgical instrument in 1928. It was his first dental electrosurgical unit to assist in achieving hemostasis.

Electrosurgical Unit

Harris defined an electrosurgical unit (ES) as "The use of specially designed electronic equipment that produces a limited variety of high-frequency waveforms to cut or remove soft tissue"(HS., 1976). While Oringer MJ. Defined it as "The application of electrically generated heat energy to living tissue to alter or destroy it for therapeutic purposes" (Oringer, 1975). There are two types of ES units, monopolar and bipolar. The bipolar type has a forceps-like electrode, whereby the electrical current passes from one tip to the other, with the targeted tissue placed between them. The monopolar type is the most common use in dentistry, as described by Gnanasekhar JD. *et al.* (Gnanasekhar & Al-Duwairi, 1998; Yalamanchili *et al.*, 2013).

There are three different waveforms: fully rectified and filtered, fully rectified and unfiltered, and partially rectified. The fully rectified, filtered waveform produces excellent tissue separation with little hemostasis and the least lateral heat. This waveform can be used for soft tissue surgeries, such as a frenectomy, incision and drainage, and gingival trough procedures around the teeth. The fully rectified, unfiltered waveform produces good tissue separation and hemostatic effect but causes tissue shrinkage and

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generates additional lateral heat, avoiding bone contact. It is suitable for gingivectomy, gingivoplasty, and pulpotomy. The partially rectified waveform causes much more lateral heat than the fully rectified, unfiltered; therefore, it can be used only as a hemostatic effect in soft tissue and as a heat source for bleaching agents (Gnanasekhar & Al-Duwairi, 1998; Yalamanchili *et al*., 2013).

Moreover, electrosurgery has an alternating current that passes through the tissue. The tissue resists the electrical current, generating lateral heat, which causes the intracellular water to boil, increasing intracellular pressure and rupturing cell membranes.

Chemical Method

Chemosurgery is another method to perform a gingivectomy. Two chemicals were used to remove the gingiva, such as 5% paraformaldehyde and potassium hydroxide. Schwarz first used formaldehyde N. *et al.* (N, 1917). Paraformaldehyde is a white powder that is not readily soluble, so it needs to be mixed with zinc oxide powder and eugenol as a liquid. This mix is called a "medicated cement pack"(Orban, 1943). Special care should be taken in applying medicated cement packs in the gingival pockets because of possible abscess formation, bone necrosis, and allergy to formaldehyde(Orban, 1943). Potassium hydroxide was advocated by Harndt E.(E, 1951). However, it is a strong alkali, and it has a necrotising effect on the gingiva and alveolar bone.

Laser System

Laser is another method for gingivectomy. "LASER" is an abbreviation of Light Amplification by the Stimulated Emission of Radiation. The laser was invented first by Theodore Maiman, USA, in 1960(Maiman, 1960). Four common types of lasers are used now in dental practice, including the Carbon dioxide laser (CO_2), the diode laser (DL), the Neodymium: Aluminum-Yttrium-Garnet (Nd: YAG), and the Erbium: Aluminum-Yttrium-Garnet (Er: YAG). Laser wavelengths in medicine and dentistry generally range from 193 nanometers (nm) to 10,600 nm. American, in 1989, produced the first dental laser for commercial use, using Nd: YAG as an active medium, but only for soft tissue surgery(Keller & Hibst, 1989). After a few years, the UK 1990 developed a machine laser using Nd: YAG as an active medium that can cut through the enamel, dentin, and bone. Shortly followed by a similar Er, Cr: YSGG (erbium chromium: yttrium scandium gallium garnet) laser in 1997(Parker, 2007a).

The laser has a clear and precise cut, good visibility related to its ability to seal blood vessels and lymph vessels during the procedure, minimal damage to adjacent tissues, and fewer postoperative complications such as pain and swelling, which increase patient satisfaction, accelerate wound healing, and less surgical time.

Carbon Dioxide Laser

Kumar Patel invented the CO_2 laser in 1964. The wavelength ranges from 9.4 to 10.6 micrometres. About 98% of the energy is converted to heat and absorbed at the tissue surface with little penetration. For decades, the CO_2 laser was the gold standard for intraoral soft tissue surgeries. The laser medium consists of water or air-cooled gas discharge (Carbon dioxide, nitrogen, hydrogen, xenon, helium) that helps produce a beam of infrared light by activating the footswitch (Viraparia *et al*., 2012). The depth of the laser incision is related to the power setting and the exposure's duration. Higher energy removes the tissue, while lower energy is used for hemostasis and photocoagulation. Continuous-wave mode forms char during the procedure. Char accumulation during the surgery leads to increased tissue temperature up to >200°C, so it is recommended to clean the surgical site to avoid thermal damage(Low & Mott, 2014). In addition, this system has no tactile feedback.

Clinical Applications of CO_2 laser (Ishikawa *et al*., 2009; Viraparia *et al*., 2012)

a) Oral and maxillofacial surgery; b) Oral medicine; c) Pre-prosthetic procedures; d) Periodontal procedures; e) Endodontics: pulpotomy, filling material removals such as gutta-percha or resin; f) Restorative procedures.

Nd: YAG

The Nd: YAG laser was developed by Geusic *et al.* in 1964. The medium is a crystal of yttrium-aluminium-garnet doped with neodymium. Have a wavelength of 1064 nm. In 1973, data were calculated for the water absorption spectrum of different lasers, such as Argon, Diode, Nd: YAG, CO_2, Er, Cr: YSGG, and Er: YAG by Hale and Querry (Hale & Querry, 1973). They showed that the energy of Nd: YAG scattered rather than being absorbed by water like a diode laser, which led to greater penetration in the soft tissue. In addition, the wavelength is attracted to colours, so this system is ideal for ablating potentially hemorrhagic abnormal tissue and hemostasis of small venous vessels and capillaries. Nd: YAG laser device has contact or non-contact probes, giving tactile feedback.

Clinical Applications of Nd: YAG laser(Ishikawa *et al*., 2009)

a) Oral and maxillofacial; b) Periodontal procedures: gingivectomy, gingivoplasty, operculum removal, bactericidal effect (Cobb, 2006), suppressing or eradicating putative periodontal pathogens from periodontal pockets (Parker, 2007b; Verma *et al*., 2012), as an adjunctive or alternative treatment to conventional mechanical therapy in periodontitis (Cobb, 2006).

Er: YAG and Cr: YSGG

As for the CO_2 laser system, it is essential for Er: YAG and Cr: YSGG that the tip be at least 1-2 mm away from the target tissue to have a good result. The erbium laser has two distinct wavelengths, 2790 - 2940 nm Cr: YSGG lasers and Er: YAG lasers, respectively, and has a high affinity for hydroxyapatite and the highest absorption of water(Ishikawa *et al*., 2009). Consequently, it is the

laser for treating dental hard tissues (Harashima *et al*., 2005). It can also be used for soft tissue ablation because it produces a little heat into the underlying tissues and elevates the pulpal temperature compared to a CO_2 laser.

Clinical Applications of Er: YAG and Cr: YSGG laser(Ishikawa *et al*., 2009) (Bader & Krejci, 2006)

a)Endodontic; b) Periodontal procedures: SRP, ablation of bone tissue, bactericidal effect on implant surface; c) Restorative procedures.

Diode Laser (DL)

The diode laser has energy absorbed by the pigmentation in the soft tissue and haemoglobin, making this system an excellent hemostatic agent (Fornaini *et al*., 2016). It is a solid semiconductor operating at 810-980 nm wavelengths. The energy is either a continuous or a pulsed mode. Using the pulsed mode during the soft tissue procedure and lowering the power setting is recommended. In contrast to other laser systems, it directly contacts the target tissue so the clinician can feel tactile feedback (Kravitz & Kusnoto, 2008).

Clinical Applications of the diode laser (Verma *et al*., 2012) (BM S, 2017)

a) Oral and maxillofacial; b) Periodontal procedures; c) Restorative procedures; d) Orthodontic; d) Endodontic.

MATERIAL AND METHODS

Research Question

The research question was, "For marginal tissue conditioning, is gingivectomy with alternative methods superior to conventional gingivectomy with a scalpel regarding patient-reported outcomes and clinical periodontal parameters?"

The protocol was constructed according to "PRISMA" (Preferred Items for Systematic Reviews and Meta-Analyses) criteria (Liberati *et al*., 2009), and a question was formulated according to "PICO." Model as mentioned in Table 1.

Table 1: PICO Model

Population	Patients in need of marginal tissue conditioning
Intervention	Gingivectomy
Comparison	Use a scalpel as a standard method, and compare it to other methods (e.g., electrosurgery and different types of laser).
Outcome	Patient's reported outcomes and clinical periodontal parameters

Search Strategy

Up to August 2019, the following MeSH keywords and free text phrases were searched in the electronic databases: Medline (PubMed), Scopus, and Web of Science (Table 2): "Gingival hyperplasia" OR "Gingival hypertrophy" OR "Gingival overgrowth" and Gingivoplasty OR Gingivectomy OR "Crown lengthening".

Table 2: Search Strategy

Sr. No	Search Strategy
1	Gingivectomy [Abstract & Keywords] OR Electrosurgery [Abstracts & Keywords] OR Diode laser [Abstract & Keywords] OR Gingival enlargement [Abstract & Keywords] OR Gingival hypertrophy [Abstract & Keywords] OR Scalpel [Abstract & Keywords] OR Gingivoplasty [Abstract & Keywords]
2	Gingival hypertrophy [tw] OR gingivectomy [tw] OR electrosurgery [tw] OR Diode laser [tw] OR Supra crestal attached tissue [tw] OR Gingival enlargement [tw] OR Gingivoplasty [tw] OR Crown lengthening [tw] OR treatment [tw] OR scalpel [tw]
3	Gingivoplasty [Abstract & Keywords] OR Gingivectomy [Abstract & Keywords] OR Gingival enlargement [Abstract & Keywords] OR Supra crestal attached tissue [Abstract & Keywords] OR Scalpel [Abstract & Keywords] OR Diode laser [Abstract & Keywords] OR Electrosurgery [tw] OR Gingival hypertrophy [tw]

Assessment of the eligibility of studies and the data extraction method

The author assessed the research based on the inclusion and exclusion criteria. Inclusion criteria for studies were selected based on articles in the English language, available as full-text, consisting of Human trials, controlled clinical trials (CCT), or randomised controlled clinical trials (RCTs) with a minimum of 10 patients per study. It also includes articles based on patients who underwent surgery for gingivectomy by using the scalpel compared with the alternative methods. In addition, exclusion criteria exclude articles based on languages other than English, Animal or Vitro studies, Case reports, clinical notes/letters, and editorials. Materials were then screened by reviewing the titles and excluding irrelevant articles for our investigation. The remaining studies' abstracts were evaluated, and the complete texts of the published literature were received. If a full-text article could not be retrieved, the author was contacted and requested the complete version. A search was also conducted in the reference lists of the selected papers. Lastly, a forward search of the listed studies was also conducted using the Science Citation Index.

Appraisal of Methodological Quality

Risk of Bias Assessment (RoB)

The methodological quality of the studies included in the systematic review was appraised as part of the data extraction process. This was performed using the Cochrane Collaboration's Risk of Bias assessment tool (Cochrane Handbook for Systematic Reviews of Interventions) (Sterne *et al*., 2019). The following criteria were evaluated at "low," "high," or "unclear" risk of bias: Randomisation process, Deviations from intended interventions, missing outcome data, Measurement of the outcome, Selection of the reported result, and Overall. Like all surgical procedures, "gingivectomy," performed using the scalpel, electrosurgical method, or other alternative procedures, requires anaesthetising the periodontal and surrounding structure. This could be done through anaesthetic gel or induction of local anaesthesia. All the included studies were evaluated individually: high risk if only one high risk were present, and unclear risk if only one of the criteria was unclear and no high-risk present.

Data Synthesis and Analysis

The extracted data from the selected studies were arranged in four tables. The first one is about the general characteristics of the selected studies, including author, year of publication, study number in Roman style, study design, randomisation procedure, participant number, age, gender, type of intervention, follow-up, co-morbidity, and drop-out. The second table presents the data of the patient's related outcome measures (PROMS). The third table reports the data, including author, year of publication, type of interventions, and periodontal parameters like PI, GI, and bleeding rate (BR). Finally, the last table shows the data of the other parameters, like the clinical observation of healing and crevicular fluid measurements.

RESULTS AND DISCUSSION

Electronic Database Search

The database searches led to the retrieval of 552 articles from the computerised database (Figure 1), with 159 duplicated studies identified and eliminated. In addition, 10 full-text studies were examined after excluding 286 papers based on the title and 97 studies based on the abstract. A further search was conducted per the reference lists from full-text, and previous review and scientific citation index, which included three full-text articles. The ultimate number of studies considered for full-text evaluation was 13. Following a comprehensive articles examination, 3 publications were excluded for differing reasons listed in Table 3. 10 publications met the eligibility criteria and were included in the present systematic review.

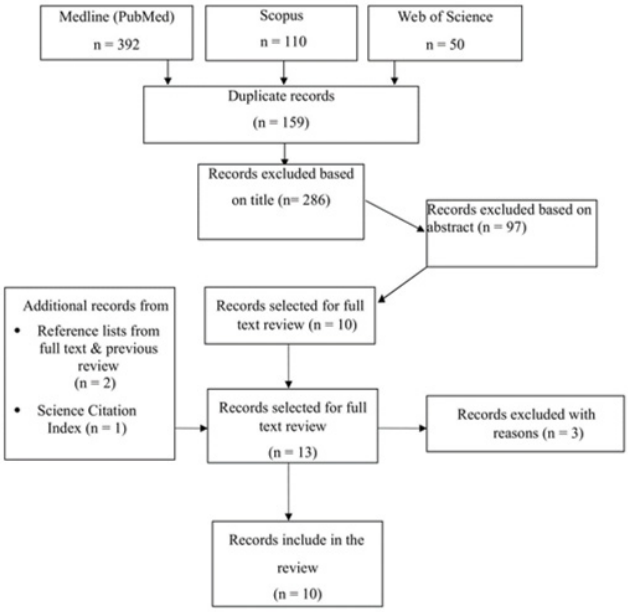

Figure 1: Flow Diagram

Table 3: Reasons for exclusion of 3 full-texts

Study (Year)	Reasons for exclusion
Petersen *et al.* (1993)	No control group
Ize-iyamu *et al.* (2013)	Less than 10 patients
Inchingolo *et al.* (2010)	Less than 10 patients

Risk of bias assessment

The risk of bias was done for the final included studies, and all the studies were assessed as low risk, except three studies, III, VI, and IX, which were high risk (Figure 2).

Study Characteristics

Ten studies were included in the systematic review, seven were RCTs, and three were CCTs; all were prospective studies. The RCTs used different randomisation techniques (see Table 4). Most studies used simple ones like coin toss or computer generator random methods. Only one study used the stratified random sample technique. The designs were variables between parallel in eight studies and split-mouth in two studies. The number of participants ranges between 11 and 58. The age of the samples ranged between 11 and 48 years old. The follow-up duration for

the samples was variable, between 2 hours and 6 months, but one study did not report the follow-up period. All the included studies reported that a full explanation of the clinical procedure was provided before participants and signed informed consent was obtained from the patients, except two studies (II, IX) that did not report. Six studies reported that the ethics committee approved them. Unfortunately, heterogeneity in the data collected was found regarding study design, type of intervention, outcome measures, and observational periods.

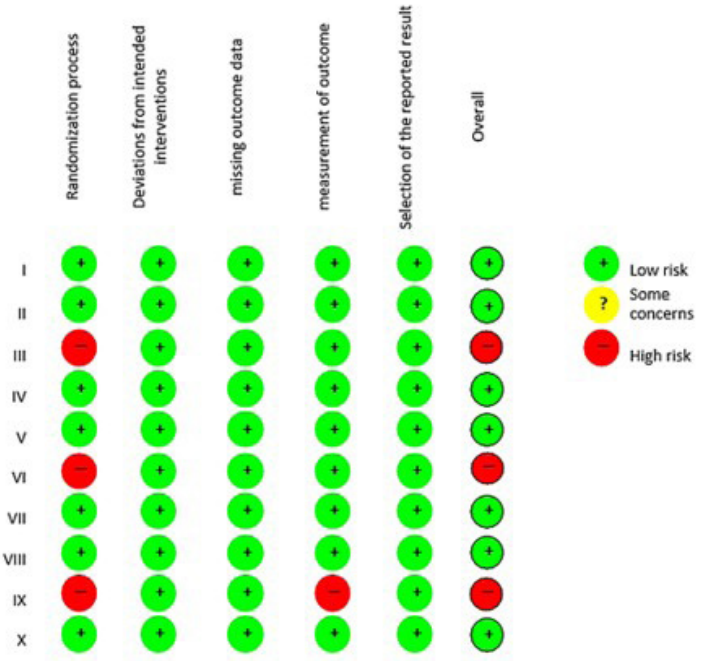

Figure 2: Risk of bias assessment

Table 4: General characteristics of included studies

Author(Year) (Ref. No.)	Study No.	Study design Randomization procedure	Participant No. Age(Years) Gender (F/M)	Typesof intervention	Follow up Co-morbidity Drop- out
Koppolu *et al.* (2016) (29)	I	Prospective RCT Parallel group Computer general randomization	14 18-30 8/6	C: Scalpel T: Diode laser	1 month None None
Aremband *et al.* (1973)(30)	II	Prospective RCT Split mouth randomisation	27 18-35 14/13	C: Scalpel T: Electrosurgical unit	1, 2, 3 weeks None None
Durham *et al.* (2009) (31)	III	Prospective CCT Split mouth	15 12-17 10/5	C: Scalpel T: Diode laser	2 months None None
Prasad *et al.* (2018) (32)	IV	Prospective RCT Parallel group Coin toss method	20 16-40 9/11	C: Scalpel T: Diode laser	7 days None 2 patients did not follow up
Öncu *et al.* (2017)(33)	V	Prospective RCT Parallel group Coin toss method	20 35.2 12/8	C: Scalpel T: Diode laser	NR None None
Akram *et al.* (2017) (34)	VI	Prospective CCT Parallel group	50 25-45 NR	C: Scalpel T: Diode laser	1 week None None
Sobouti *et al.* (2014) (35)	VII	Prospective RCT Parallel group	30 17-29 18/12	C: Scalpel T: diode Laser	2 hours None None

Lione *et al.* (2019)(59)	VIII	Prospective RCT Parallel group Computer generated randomization	58 11.7-19.8 26/32	C:non-surgical T:Scalpel T:diode laser	6 months None 2 patients
Mussa *et al.* (2017) (37)	IX	Prospective CCT Parallel group	30 17-34 14/16	C:Scalpel T:Diode laser	1, 2 week None None
Kumar *et al.* (2015) (38)	X	Prospective RCT Parallel group	10 20-40 NR	C:Scalpel T:Diode lasr	24, 36h 1, 2, 3 week None None

Types of reported outcome variables

PROMS

Most studies performed quantitative and qualitative assessments regarding PROMs and clinical periodontal outcomes, but the primarily quantitative assessment was performed. PROMs were reported in the form of a scale and as a subjective assessment. VAS scales of pain and discomfort were reported together in one study (IV) and as separate scales; e.g., the VAS scale of pain was presented similarly (10cm) in five studies (I, III, V, VII, X). In contrast, the VAS scale of comfort was presented only in one study. In addition, one study (IV) reported the frequency of pain at different time intervals.

Another study (X) presented patients' satisfaction levels. A qualitative assessment regarding the pain and discomfort was performed in one study (VI). Patients were investigated if they experienced the pain of equal severity on both sides or more severe on one side, if they needed to use any pain killer, and if there was any discomfort and difficulty during speech and eating. Another qualitative assessment was done in one study (I) regarding the cosmetic outcome by evaluating the patient's perception of cosmetic change and expected outcome.

Effect of Diode laser: Pain

Two studies performed the mean VAS scores [RoB: low (I, X)] on the first day and were significantly lower in the laser groups than in the scalpel groups. Another study reported lower pain values in the laser than in the scalpel in the first two days [RoB: high (VI)] with no statistical analysis. Three studies [RoB: low (I, IV, VII)] presented the VAS scores on the third and seventh days of follow-up and were significantly low in the laser groups in comparison with the scalpel groups in two studies only (IV, VII). One study [RoB: low (V)] presented that the mean VAS values for the whole evaluation period and significantly lower in the test groups than in the control groups. Only one study [RoB: high (III)] evaluated the VAS of pain daily for seven days. It showed a lower significant value in the laser group than in the scalpel group on the third day. Study (IV) evaluated the frequency of pain on the third, fifth, and seventh days, and it was significantly low in the laser group than in the scalpel group.

Studies (VI, VII) presented how many analgesics the patient consumed. It was significantly high in the control groups than in the test groups after 82 minutes postsurgical in the study (VII), while the other study (VI)

Table 5: Comparison b/t diode laser & scalpel regarding PROMs.

Author (Year) (Ref. No.)	**Study No.**	**PROM/PROMS**					
Koppolu *et al.* (2016) (29)	I	VAS of pain		Patient's perception of cosmetic		Patient evaluation for perception regarding expected outcome from the treatment after 4th week	
		day 1.29* 3 day 0.25 7 day 0.0	1 day 3.1 3 day 1.98 7 day 0.25	1 W mild=1 moderate=3 sufficient=3 2 W mild=0 moderate=3 sufficient=4 4 W mild=0 moderate=2 sufficient=5	moderate=3 sufficient=2 2 W mild=2 moderate=3 sufficient=2 4 W mild=1 moderate=3 sufficient=2	Unsatisfied=0 P. satisfied=2 T. satisfied=5	unsatisfied=2 P. satisfied=2 T. satisfied=3

Durham *et al.* (2009) (31)	III	VAS of pain					
		1 day (1.9) 2 day (0.5) 3 day (0.3)* 4 day (0.2) 5 day (0.1) 6 day (0.1) 7 day (0.1)			1 day (1.4) 2 day (0.9) 3 day (0.4) 4 day (0.4) 5 day (0.2) 6 day (0.1) 7 day (0.1)		
Prasad *et al.* (2018) (32)	IV	VAS of pain & discomfort				Frequency of pain at different time intervals (intermittent pain/no pain)	
		3 day 0.50* 5 day 0.10* 7 day 0.30*		3 day 2.0 5 day 1.10 7 day 1.00		3 day 50%/50%* 5 day 10%/90%* 7 day 30%/70%*	3 day 100%/0% 5 day 100%/0% 7 day 90%/10%
Öncu *et al.* (2017) (33)	V	VAS of pain					
		2.4*				7.1	
Akram *et al.* (2017) (34)	VI	Pain (n)		Discomfort		Analgesic consumption (n)	
		Experience some pain for the first two days (15)	Experience some pain for the first two days (21)	Experience some discomfort in speech & eating (0)	Experience some discomfort in speech & eating (25)	(60%)	(84%)
Kumar *et al.* (2015)(38)	X	VAS of pain		VAS of comfort		Patient's satisfaction	
		During surgery (3) 24-36h (2)*	During surgery (1) 24-36h (4)	1 week (19)*	1 week (16)	3 week (8)	3 week (6)
Sobouti *et al.* (2014) (35)	VII	VAS of pain			Analgesic consumption (n)		
		Postsurgical 0.0*		Postsurgical 5.2		(0)	(14)* after 82 minutes

*Ref reference, No number, Grey shade box= test group, VAS visual analogue scale, *statistical significant between test & control groups, W week, P partial, T total, (n) number of patients, H hour.*

showed high analgesic consumption in the control group than in the test group but did not perform statistically analysis (see Table 5).

Discomfort

Two studies [RoB: low (IV); high (VI)] evaluated discomfort values, and one study [RoB: low (X)] evaluated the VAS of comfort. Study (VI) reported that all patients experienced discomfort during speech and eating in the control groups. Another study (X) showed a higher significant value of VAS of comfort in the laser group than in the scalpel group after a week. The other study (IV) showed lower significant discomfort values in the laser groups than the scalpel groups on the third and seventh days (see Table 5).

Effects of Electrosurgery Pain

The pain was evaluated in one study [RoB: low (II)] by asking about the patient's experience after one week and showed no significant difference between the electrosurgery and scalpel groups. However, the VAS scale of discomfort was not performed (Table 6).

Table 6: Comparison b/t electrosurgery & scalpel regarding PROMs.

Author (Year) (Ref. No.)	Study No.		PROM/PROMS
Aremband *et al.* (1973)(30)	II	Patient's experience 6.67%	Patient's experience 10%

Periodontal Parameters

We found six studies that reported the periodontal parameters. The PI and GI were presented in four studies [RoB: high (III, VI, IX); low (VIII)]. The bleeding parameter was presented as a scale in two studies [RoB: low (V, VII)] and as subjective data in one study (IX).

One study presented the PD and the clinical crown length (VIII). Another study (IX) assessed the swelling and presented subjective data (see Table 5).

Effect of Diode laser

PI and GI were performed in four studies [RoB: low (VIII); high (III, VI, IX)]. Three studies (III, VI, IX) evaluated the PI after a week postoperatively. No significant difference was recorded between the laser and scalpel groups (III, IX). Study (VI) presented a higher significant postoperative value in the control group compared to the preoperative value. The PI was evaluated after two weeks postoperatively (IX), after a month in two studies (III, VIII), and after six months in another study (VIII), and showed no significance between the laser and scalpel groups.

In contrast, the GI was presented significantly higher in the control groups in comparison to the test groups after a week (VI, IX) and also after two weeks (IX), but study (III) showed no significance. The evaluation of GI after a month (III, VIII) and after three and six months (VIII) did not show any significant values. Other periodontal parameters like PD and clinical crown height were evaluated in one study (VIII) after one, three, and six-month observation periods and showed a significant reduction in the PD. A significant increase in the clinical crown height after one month versus baseline values in the two test groups was observed compared to the control groups, but no significant difference between the two test groups. After three months of follow-up, a relapse occurred in the test groups with a decrease in the clinical crown height and an increase in the PD, but not significant when compared with the control groups or between the test groups. When observing six months versus three months, no significant difference was found between the groups in PD and clinical crown height.

The bleeding was assessed in three studies [RoB: low (V, VII); high (IX)] in two different ways. Study (IX) evaluated the bleeding by grading the following criteria: none, self-limiting, require pressure, coagulation, and require ligation or hemoclip. All the patients required pressure in the control group, while in the test group, only one patient required pressure, two patients were self-limiting bleeding, and eleven patients did not bleed. Studies (V, VII) reported a significantly lower bleeding rate in the test group than in the control group. Only one study (IX) evaluated the swelling according to the following: None, slight, moderate, and severe. No swelling was reported in the test group compared to the control group, while three patients showed slight swelling in the control group (Table 7).

Table 7: Comparison b/t diode laser & scalpel regarding Periodontal Parameters

Author (Year) (Ref. No.)	Study No.	Periodontal Parameters											
		PI			GI			PD (mm)			CCL (mm)		
		DL	Scalpel	None Surgery	DL	Scalpel	None Surgery	DL	Scalpel	None Surgery	DL	Scalpel	None Surgery
Lione *et al.* (2019) (36)	VIII	B 0.4 1 M 0.6 3 M 0.7 6 M 0.6	B0.4 1 M 0.6 3 M 0.5 6 M 0.6	B 0.6 1 M 0.5 3 M 0.4 6 M 0.7	B 0.3 1 M 0.5 3 M 0.6 6 M 0.7	B 0.3 1 M 0.5 3 M 0.6 6 M 0.7	B 0.5 1 M 0.4 3 M 0.5 6 M 0.6	B 4.8 P.S 0.7 1 M 1.8*	B 4.9 P.S 0.9 1 M 1.8*	B 4.4 1 M 4.0 3 M 3.3 6 M 3.8	B 7.7 P.S 10.6 1 M 10.1*	B 7.9 P.S 10.3 1 M 9.9*	B 7.6 1 M 8.0 3 M 8.3 6 M 8.2
		PI (n)			GI (n)			Intraoperative bleeding (n)			Swelling (n)		
		Test	Control		Test	Control		Test	Control		Test	Control	
Mussa *et al.* (2017) (14)	IX	BL 0.51 1 week 0.38 2 week 0.28	BL 0.46 1 week 0.37 2 week 0.38		BL 0.72 1 week 0.55* 2 week 0.29*	BL 0.85 1 week 1.45 2 week 0.68		None 11 Self-limit 2 Pressure 1 Coagulation 0 Ligation or hemoclip 0	None 0 Self-limit 0 Pressure 16 Coagulation 0 Ligation or hemoclip 0		None 14 Slight 0 Moderate 0 Severe 0	None 13 Slight 3 Moderate 0 Severe 0	

Akram *et al.* (2017) (34)	**VI**	#Scaling 1.22 #Surgery 0.3 1 week 0.41	#Scaling1.37 #Surgery.0.39 1 week 1.31*	#Scaling 1.18 #Surgery 0.44 1 week 0.53	#Scaling 1.34 #Surgery. 0.52 1 week 0.91*
Sobouti *et al.* (2014) (35)	**VII**	Bleeding rate			
		0.36 out of 4*		1.15 out of 4 1.32	
Oncu *et al.* (2017) (33)	**V**	1 week: 0 (26) 1 (13) 2 (13)	1 week: 0 (29) 1 (10) 2 (14)	1 week: 0 (0) 1 (12) 2 (34) 3 (6)	1 week: 0 (0) 1 (3) 2 (38) 3 (12)
Durham *et al.* (2009)(31)	**III**	1 month: 0 (14) 1 (24) 2 (14)	1 month: 0 (14) 1 (21) 2 (18)	1 month: 0 (4) 1 (35) 2 (13) 3 (0)	1 month: 0 (4) 1 (29) 2 (20) 3 (0)

*Ref reference, No number, Gray shade box= test group, PI plaque index, GI gingival index, PD pocket depth, CCL clinical crown length, (mm) millimeter, DL diode laser, BL baseline, M month, P.S post-surgery, (n) number of patients, *statistical significant, # before.*

Effects of Electrosurgery

Only one study observed clinically and photographically the healing process [RoB: low (II)]. No significant difference was found between the groups after seven and fourteen days in periodontal measures due to the electrosurgical procedure (see Table 8).

Table 8: Comparison b/t electrosurgery & scalpel regarding Periodontal Parameters

Author (Year) (Ref. No.)	**Study No.**	**Periodontal Parameters**	
		Clinical Observation of Healing	Photograpahic Observation of healing
Aremband *et al.* (1973)(30)	II	1week(30%) 2 week (6.67%) 3 weeks (6.67%)	1 week (13.33%) 2 weeks (16.67%) 3 weeks (16.67%)

DISCUSSION

The present systematic review aimed to provide evidence for the superiority of using different techniques for gingivectomy over the conventional method using a scalpel regarding patient perceptions and periodontal parameters. The main reason for switching from the surgical scalpel to other methods is the need for hemostatic action during the surgical procedure for a better surgical field. Three different methods were developed, and all provide excellent hemostatic action. However, these methods have disadvantages, including leakage of chemical materials such as paraformaldehyde and potassium hydroxide into the surrounding tissues, makings it not recommended for periodontal surgery.

The electrosurgical method has also provided an excellent hemostatic action by sealing the blood vessels while cutting the desired tissue. However, care should be taken when choosing the waveform and power input because lateral heat could cause necrosis to the neighbouring tissues. The last method, laser with different active media for different types of tissues, also provides a hemostatic effect. However, all types of laser have a thermal effect on the surrounding tissues, which depends on the power input.

Diode laser & patient outcome

Based on the limited clinical evidence, the present systematic review found two alternative methods for gingivectomy, diode laser and electrosurgery. The results indicate that the laser technique causes less postoperative pain and discomfort than the traditional scalpel, especially in the first week. Even though one study (Akram *et al.*, 2017) did not perform statistical analysis. However, the VAS scores were low in the laser group compared to the scalpel group in the first two days, and because of that, the patients did not consume excessive painkillers like in the scalpel groups.

Our results are from a previous study by Kalakonda B. *et al.*, 2016, where they performed vestibulopathy in 20 patients and compared the scalpel group with the diode laser group. They presented a significantly lower VAS pain score in the laser group than the scalpel group on the 1st, 3rd, and 7th days (Kalakonda *et al.*, 2016). Also, in the

study of Ize-iyamu I N. *et al.*, 2013(Ize-Iyamu *et al.*, 2013), they performed maxillary frenectomy, operculectomy, aesthetic recontouring, and surgical exposure, in addition to gingivectomy. Again, they reported lower significant values in the laser group than in the scalpel group.

Furthermore, even though they used the diode laser in other oral soft tissue surgeries, they showed significantly lower VAS of pain in the laser groups than in the scalpel groups (Fisher SE, 1983) (Fisher & Frame, 1984; Koppolu *et al.*, 2017). Another theory is that a diode laser produces minor collateral tissue damage during the incision, even with a continuous wave at a higher power level of 4.5W than other lasers like CO2, and less postoperative pain (Durham, 2009) (Goharkhay *et al.*, 1999). Also, the results herein showed that some of the included studies (Koppolu *et al.*, 2017) (Elif, 2017) used only topical anaesthesia, either gel or spray, before the surgery, and most of the patients did not need infiltration of local anaesthesia for the laser procedure. This could be one of the advantages of using a laser for gingivectomy in children (Do Hoang Viet *et al.*, 2019).

Diode laser & periodontal parameters outcome

Another observation is that using a scalpel caused more gingival inflammation when compared with a laser; due to the periodontal dressing used in the scalpel group, which acts as plaque retention (Akram *et al.*, 2017). Even though the PI was low in other studies (Durham, 2009; Lione *et al.*, 2020; Sobouti *et al.*, 2014) (Musaa *et al.*, 2017), the inflammation was low in the test group. The reason for low GI is due to irradiation. Instead, there is almost instantaneous vaporisation of the intracellular fluid and thus disintegrating cell structure, which might not release the chemical mediators of inflammation. In addition, a thin layer of denatured collagen formed on the surface will act as a protective layer and prevent tissue irritation, thus decreasing inflammation (Fisher *et al.*, 1983).

Only one study, (Kumar *et al.*, 2015) assessed the postoperative healing process using the healing index. Better healing was observed in incisions done by the scalpel but was not statistically significant. This is the result of Fisher and his colleagues in 1983 (Fisher *et al.*, 1983). They examined animal models for observing histological changes during healing after using a CO2 laser on buccal mucosa and found no differences in the mitotic rate of the epithelium between the groups. In contrast, some studies showed that laser irradiation could stimulate fibroblast proliferation without impairing procollagen synthesis, thus improving wound healing(Pereira *et al.*, 2002). However, we had to know that these studies used low power output (120mW), which is much less than what was used in our included studies (0.8-2W), and those high power caused thermal tissue damage around the incision, according to Goharkhay K. *et al.*, 1999 (Goharkhay *et al.*, 1999).

Since the main advantage of laser over the scalpel is the hemostatic effect, which provides a clear surgical field during the surgery, three studies assessed the bleeding criteria during the procedure (Elif, 2017) (Sobouti *et al.*, 2014) (Musaa *et al.*, 2017). The bleeding assessment showed that the diode laser controlled the bleeding. This result was confirmed by a study by Ize-iyamu I. N. *et al.*, 2013 (Ize-Iyamu *et al.*, 2013). They performed various oral surgical procedures, such as a maxillary frenectomy, operculectomy, surgical exposure, and gingivectomy, using an 810nm diode laser compared with the conventional scalpel. They showed that the laser groups had grade 0 (no bleeding), and the scalpel groups had grade 1 (petechial bleeding) according to the WHO bleeding scale. A case report also confirmed our results (Asnaashari *et al.*, 2013), where they treated gingival hyperplasia using an 810nm diode laser and noticed minor bleeding during the procedure.

Electrosurgery & Patient Outcome

On the other hand, the electrosurgical method did not differ from the scalpel regarding postoperative pain and discomfort. This result was confirmed by a comparative study by Chandra R. V. *et al.*, 2016. They performed a gingivectomy to reduce the PD and observed that the pain on a surgical day and after seven days did not differ between the control and test groups. A case series report (Bhusari & Kasat, 2011) concluded the same results.

Electrosurgery & periodontal parameters outcome

In addition, Armband D. *et al.*(Aremband & Wade, 1973) observed the healing process clinically, photographically, and histologically. No differences were presented between group (Eisenmann D, 1970). This study follows Glickman I. and Imber L. R.'s study (Glickman & Imber, 1970), where they did a histological study on animals by performing a shallow resection (away from the bone) and deep resection (as close as possible to the crest of the bone). They presented that the microscopic findings of shallow resection samples after 3, 6, and 12 weeks were the same between the groups, the epithelium was inflamed with slight hyperplasia, and the underlying bone was unaltered. In contrast, the samples from the deep resection in the test group showed bone necrosis.

In contrast, a study by Manivannan N. *et al.*(Manivannan *et al.*, 2013) measured the vascularity of the gingiva pre- and postoperative by using the ultrasound Doppler technique. The results showed that the re-vascularisation rate was faster in the control group than in the test group, thus improving the healing process, implying minor postoperative complications and more patient comfort. Finally, a histological study by Sinha U. K. *et al.*, 2003(Sinha & Gallagher, 2003) confirmed the previous study. They compare the performance of the scalpel with electrosurgery by creating oral mucosal incisions in the guinea pigs. They showed that the fast healing utilising re-epithelialisation was in the scalpel groups, and complete epithelial healing had taken place by the end of the first week.

In contrast, in the electrosurgery groups, the re-epithelialisation had occurred by the end of the fourth week. Another study done by Chandra R. V. *et al.*(Chandra *et al.*, 2016) also showed a clinical delay in healing in the

electrosurgery group compared with the scalpel group after 7 and 15 days of follow-up. It was explained by the lateral heat produced from the electrode tip during the incision process.

Other types of laser & patient outcome

Many comparative studies used CO_2, Nd: YAG, and Er: YAG lasers compared with the scalpel for other oral soft tissue surgeries like frenectomy and excisional biopsy (Haytac & Ozcelik, 2006) (López-Jornet & Camacho-Alonso, 2013; Natekar *et al*., 2017) (Tambuwala *et al*., 2014) (Akpınar *et al*., 2016; Prasad R, 2018; Yadav *et al*., 2019) (Kara, 2008) (Vickers, 2017) (Broccoletti *et al*., 2015). These studies showed that the conventional technique exhibited higher postoperative pain and discomfort values than the laser technique. In addition, the studies of this systematic review also state that the laser method has an advantage over the scalpel in providing more comfort and producing less pain after the surgical procedure.

Even though a study incorporating electrosurgical methods, conducted on twenty patients, presented a high value of postoperative pain than the laser in gingival depigmentation surgery.(Chandna & Kedige, 2015) The VAS score of pain was statistically significantly lower in the laser groups after 24 hours, but no significant differences were found after a week between the groups.

This systematic review concluded that a diode laser had better patient outcomes in pain and discomfort than a scalpel. However, the current systematic review only included ten studies, and most studies had few patients in each group. Hence, there was insufficient data to conclude the results between the diode laser and scalpel in terms of periodontal parameters and between the ES unit and the scalpel for patient outcome and periodontal parameters. Furthermore, one research comparing the ES unit and scalpel for the gingivectomy technique was reported. Based on the available data, a diode laser is the most recommended approach (technology) for crown lengthening. However, no meta-analysis was performed because the research designs and observational durations were heterogeneous.

CONCLUSION

Diode laser was the most appropriate technique for gingival recontouring and deep pockets elimination because the surgery could be performed by applying topical anaesthesia. Also, infiltration did not require most of the time, and the patient will experience less pain and discomfort after the procedure compared to the scalpel technique. However, many studies showed the same results, but they performed different types of soft tissue surgeries like vestibulopathy and frenectomy and used different types of lasers such as CO_2, Nd: YAG. Clinicians need to understand that each type of laser has different absorption coefficients with primary tissue components (water-mineral-melanin), making the laser selection procedure dependent. For example, the CO_2 laser is highly soluble in water, which means it is suitable for oral soft tissue surgeries, while the diode laser is highly absorbable in pigmented tissue and less absorbable in water than CO_2, so it is suitable for gingival surgeries since the gingiva has a high content of melanin. The clinician should first determine the specific requirement of the clinical treatment and then select the suitable laser to achieve the desired prognosis.

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REFERENCES

Akpınar, A., Toker, H., Lektemur Alpan, A., & Çalışır, M. (2016). Postoperative discomfort after Nd: YAG laser and conventional frenectomy: comparison of both genders. *Australian dental journal, 61*(1), 71-75.

Akram, H. M., Ali, O. H., Omran, N. K., & Ali, A. O. (2017). Diode laser versus scalpel gingivectomy. *Biomedical and Pharmacology Journal, 10*(4), 1799-1804.

Aremband, D., & Wade, A. B. (1973). A comparative wound healing study following gingivectomy by electrosurgery and knives. *Journal of periodontal research, 8*(1), 42-50.

Asnaashari, M., Azari-Marhabi, S., Alirezaei, S., & Asnaashari, N. (2013). Clinical application of 810nm diode laser to remove gingival hyperplasic lesion. *Journal of Lasers in Medical Sciences, 4*(2), 96.

Bader, C., & Krejci, I. (2006). Indications and limitations of Er: YAG laser applications in dentistry. *American journal of dentistry, 19*(3), 178-186.

Bhusari, B., & Kasat, S. (2011). Comparison between scalpel technique and electrosurgery for depigmentation: A case series. *Journal of Indian Society of Periodontology, 15*(4), 402.

BM S, B. W., S J, Srihari. . (2017). Current Uses of Diode Lasers in Dentistry. *Otolaryngology, 07*(02), 1-4.

Broccoletti, R., Cafaro, A., Gambino, A., Romagnoli, E., & Arduino, P. G. (2015). Er: YAG laser versus cold knife excision in the treatment of nondysplastic oral lesions: a randomized comparative study for the postoperative period. *Photomedicine and laser surgery, 33*(12), 604-609.

Chandna, S., & Kedige, S. D. (2015). Evaluation of pain on use of electrosurgery and diode lasers in the management of gingival hyperpigmentation: A comparative study. *Journal of Indian Society of Periodontology, 19*(1), 49.

Chandra, R. V., Savitharani, B., & Reddy, A. A. (2016). Comparing the outcomes of incisions made by colorado microdissection needle, electrosurgery tip, and surgical blade during periodontal surgery: A randomized controlled trial. *Journal of Indian Society of Periodontology, 20*(6), 616.

Cobb, C. M. (2006). Lasers in periodontics: a review of

the literature. *Journal of periodontology, 77*(4), 545-564.

Do Hoang Viet, V. T. N., Ngoc, L. Q. A., Le Hoang Son, D.-T. C., & Phung Thi Thu Ha, T. C. (2019). Reduced need of infiltration anesthesia accompanied with other positive outcomes in diode laser application for frenectomy in children. *Journal of Lasers in Medical Sciences, 10*(2), 92.

Durham, J. R. (2009). A comparison of two soft tissue gingivectomy techniques University of Alabama–Birmingham].

E, H. (1951). Paradentitis and paradentosis. *Oral Surg Oral Med Oral Pathol. , 4*(1), 126.

Eisenmann D, M. W., Kusek J. (1970). Electron microscopic evaluation of electrosurgery. . *Oral Surg Oral Med Oral Pathol., 29*(5), 660-665. http://www.ncbi.nlm.nih.gov/pubmed/5265873

Elif, Ö. (2017). Comparison of gingivectomy procedures for patient satisfaction: conventional and diode laser surgery. *Selcuk Dental Journal, 4*(1), 6-9.

Fisher SE, F. J., Browne RM. (1983). A comparative histological study of wound healing following CO2 laser and conventional surgical excsion of canine buccal mucosa. *Arch Oral Biol., 28*(2), 87-91.

Fisher, S. E., Frame, J., Browne, R., & Tranter, R. (1983). A comparative histological study of wound healing following CO2 laser and conventional surgical excision of canine buccal mucosa. *Archives of oral Biology, 28*(4), 287-291.

Fisher, S. E., & Frame, J. W. (1984). The effects of the carbon dioxide surgical laser on oral tissues. *British journal of oral and maxillofacial surgery, 22*(6), 414-425.

Fornaini, C., Merigo, E., Sozzi, M., Rocca, J.-P., Poli, F., Selleri, S., & Cucinotta, A. (2016). Four different diode lasers comparison on soft tissues surgery: a preliminary ex vivo study. *Laser Therapy, 25*(2), 105-114.

Glickman, I., & Imber, L. R. (1970). Comparision of Gingival Resection with Electrosurgery and Periodontal Knives—A Biometric and Histologic Study. *Journal of periodontology, 41*(3), 142-148.

Gnanasekhar, J. D., & Al-Duwairi, Y. S. (1998). Electrosurgery in dentistry. *Quintessence international, 29*(10).

Goharkhay, K., Moritz, A., Wilder-Smith, P., Schoop, U., Kluger, W., Jakolitsch, S., & Sperr, W. (1999). Effects on oral soft tissue produced by a diode laser in vitro. Lasers in Surgery and Medicine: *The Official Journal of the American Society for Laser Medicine and Surgery, 25*(5), 401-406.

Hale, G. M., & Querry, M. R. (1973). Optical constants of water in the 200-nm to 200-µm wavelength region. *Applied optics, 12*(3), 555-563.

Harashima, T., Kinoshita, J.-I., Kimura, Y., Brugnera Jr, A., Zanin, F., Pecora, J. D., & Matsumoto, K. (2005). Morphological comparative study on ablation of dental hard tissues at cavity preparation by Er: YAG and Er, Cr: YSGG lasers. *Photomedicine and Laser Therapy, 23*(1), 52-55.

Haytac, M. C., & Ozcelik, O. (2006). Evaluation of patient perceptions after frenectomy operations: a comparison of carbon dioxide laser and scalpel techniques. *Journal of periodontology, 77*(11), 1815-1819.

HS., H. (1976). Electrosurgery in Dental Practice. 3. *Blackwell Scientific Publications.*

Ishikawa, I., Aoki, A., Takasaki, A. A., Mizutani, K., Sasaki, K. M., & Izumi, Y. (2009). Application of lasers in periodontics: true innovation or myth? *Periodontology 2000, 50*(1), 90-126.

Ize-Iyamu, I., Saheeb, B., & Edetanlen, B. (2013). Comparing the 810nm diode laser with conventional surgery in orthodontic soft tissue procedures. *Ghana medical journal, 47*(3), 107-111.

Jepsen, S., Caton, J. G., Albandar, J. M., Bissada, N. F., Bouchard, P., Cortellini, P., Demirel, K., de Sanctis, M., Ercoli, C., & Fan, J. (2018). Periodontal manifestations of systemic diseases and developmental and acquired conditions: Consensus report of workgroup 3 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. *Journal of clinical periodontology, 45,* S219-S229.

Kalakonda, B., Farista, S., Koppolu, P., Baroudi, K., Uppada, U., Mishra, A., Savarimath, A., & Lingam, A. S. (2016). Evaluation of patient perceptions after vestibuloplasty procedure: a comparison of diode laser and scalpel techniques. Journal of clinical and diagnostic research: *JCDR, 10*(5), ZC96.

Kara, C. (2008). Evaluation of patient perceptions of frenectomy: a comparison of Nd: YAG laser and conventional techniques. *Photomedicine and laser surgery, 26*(2), 147-152.

Keller, U., & Hibst, R. (1989). Experimental studies of the application of the Er: YAG laser on dental hard substances: II. Light microscopic and SEM investigations. *Lasers in surgery and medicine, 9*(4), 345-351.

Koppolu, P., Kalakonda, B., Mishra, A., Lingam, A. S., Elkhatat, E., Ibrahim, A. A., Alhegbani, F. A., Alshahrani, F. S. F., Nassar, A. I., & Abdulaziz, A. A. (2017). Smile Correction Using an Esthetic Crown Lengthening with Either Diode Laser or Scalpel–A Comparative Clinical Patient Perspective Study. *British Journal of Medicine and Medical Research, 19,* 1-9.

Kravitz, N. D., & Kusnoto, B. (2008). Soft-tissue lasers in orthodontics: an overview. *American journal of orthodontics and dentofacial orthopedics, 133*(4), S110-S114.

Kumar, R., Jain, G., Dhodapkar, S. V., Kumathalli, K. I., & Jaiswal, G. (2015). The comparative evaluation of patient's satisfaction and comfort level by diode laser and scalpel in the management of mucogingival anomalies. *Journal of clinical and diagnostic research: JCDR, 9*(10), ZC56.

Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P., Clarke, M., Devereaux, P. J., Kleijnen, J., & Moher, D. (2009). The PRISMA statement for reporting systematic reviews and

meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *Journal of clinical epidemiology, 62*(10), e1-e34.

Lione, R., Pavoni, C., Noviello, A., Clementini, M., Danesi, C., & Cozza, P. (2020). Conventional versus laser gingivectomy in the management of gingival enlargement during orthodontic treatment: a randomized controlled trial. *European journal of orthodontics, 42*(1), 78-85.

López-Jornet, P., & Camacho-Alonso, F. (2013). Comparison of pain and swelling after removal of oral leukoplakia with CO_2 laser and cold knife: a randomized clinical trial. *Medicina oral, patologia oral y cirugia bucal, 18*(1), e38.

Low, S. B., & Mott, A. (2014). Laser technology to manage periodontal disease: a valid concept? *Journal of Evidence Based Dental Practice, 14,* 154-159.

Maiman, T. (1960). *NPG library. Nature, 187,* 493-494.

Manivannan, N., Ahathya, R., & Rajaram, P. (2013). Scalpel versus electrosurgery: Comparison of gingival perfusion status using ultrasound Doppler flowmetry. *Journal of Pharmacy & Bioallied Sciences, 5*(Suppl 2), S154.

Musaa, F. E., Awazli, L. G., & Alhamdani, F. (2017). Gingival enlargement management using diode laser 940 nm and conventional scalpel technique (A comparative study). *Iraqi Journal of Laser, 16*(B), 1-9.

N, S. (1917). Formaldehyde for Treatment of Alveolar Pyorrhea. *Vrtljschr f Zahnheilk, 33,* 403.

Natekar, M., Raghuveer, H.-P., Rayapati, D.-K., Shobha, E.-S., Prashanth, N.-T., Rangan, V., & Panicker, A. G. (2017). A comparative evaluation: Oral leukoplakia surgical management using diode laser, CO2 laser, and cryosurgery. *Journal of Clinical and Experimental Dentistry, 9*(6), e779.

Orban, B. (1943). Gingivectomy by chemosurgery. The *Journal of the American Dental Association, 30*(3), 198-202.

Oringer, M. J. (1975). Electrosurgery in dentistry. WB Saunders Company.

Parker, S. (2007a). Introduction, history of lasers and laser light production. *British dental journal, 202*(1), 21-31.

Parker, S. (2007b). Lasers and soft tissue: periodontal therapy. *British dental journal, 202*(6), 309-315.

Pereira, A. N., Eduardo, C. d. P., Matson, E., & Marques, M. M. (2002). Effect of low-power laser irradiation on cell growth and procollagen synthesis of cultured fibroblasts. Lasers in Surgery and Medicine: *The Official Journal of the American Society for Laser Medicine and Surgery, 31*(4), 263-267.

Perry, J., Parker, G., & Jagger, J. (2003). Scalpel blades: reducing injury risk. *Adv Exposure Prev, 6*(4), 37-40.

Prasad R, B. R. D., Raj A, J.N S, B. B. . (2018). Comparative assessment of pain associated with soft tissue crown lengthening using laser and conventional scalpel techniques. . *Int J Recent Sci Res, 9*(4), 25566–25570.

Sinha, U. K., & Gallagher, L. A. (2003). Effects of steel scalpel, ultrasonic scalpel, CO_2 laser, and monopolar and bipolar electrosurgery on wound healing in guinea pig oral mucosa. *The Laryngoscope, 113*(2), 228-236.

Sobouti, F., Rakhshan, V., Chiniforush, N., & Khatami, M. (2014). Effects of laser-assisted cosmetic smile lift gingivectomy on postoperative bleeding and pain in fixed orthodontic patients: a controlled clinical trial. *Progress in orthodontics, 15*(1), 1-5.

Sterne, J. A., Savović, J., Page, M. J., Elbers, R. G., Blencowe, N. S., Boutron, I., Cates, C. J., Cheng, H.-Y., Corbett, M. S., & Eldridge, S. M. (2019). *RoB 2: a revised tool for assessing risk of bias in randomised trials. bmj, 366*.

Tambuwala, A., Sangle, A., Khan, A., & Sayed, A. (2014). Excision of oral leukoplakia by CO2 lasers versus traditional scalpel: a comparative study. *Journal of maxillofacial and oral surgery, 13*(3), 320-327.

Verma, S. K., Maheshwari, S., Singh, R. K., & Chaudhari, P. K. (2012). Laser in dentistry: An innovative tool in modern dental practice. *National journal of maxillofacial surgery, 3*(2), 124.

Vickers, N. J. (2017). Animal communication: when i'm calling you, will you answer too? *Current biology, 27*(14), R713-R715.

Viraparia, P., White, J. M., & Vaderhobli, R. M. (2012). CO2 Laser: Evidence Based Applications in Dentistry. In CO_2 Laser-Optimisation and Application. IntechOpen.

Yadav, R. K., Verma, U. P., Sajjanhar, I., & Tiwari, R. (2019). Frenectomy with conventional scalpel and Nd: YAG laser technique: A comparative evaluation. *Journal of Indian Society of Periodontology, 23*(1), 48.

Yalamanchili, P. S., Davanapelly, P., & Surapaneni, H. (2013). Electrosurgical applications in Dentistry. *Sch J App Med Sci, 1*(5), 530-534.