Asian Journal of Periodontics and Orthodontics
2024, Volume 4, Page No: 52-59
Copyright CC BY-NC-SA 4.0
Available online at: www.tsdp.net

ISSN: 3062-3499

Review Article

Diode Laser vs. Retraction Cord: Evaluating Gingival Retraction Efficacy in Prosthodontics

Desislava R. Makakova[1], Plamen Zagorchev[2], Mariya Dimitrova[1]*, Yoanna Georgieva[1], Boris Tilov[3]

[1]Department of Prosthetic Dentistry, Faculty of Dental Medicine, Medical University of Plovdiv, 4002 Plovdiv, Bulgaria.
[2]Department of Medical Physics, Biophysics and Mathematics, Faculty of Pharmacy, Medical University of Plovdiv, 4002 Plovdiv, Bulgaria.
[3]Medical College, Medical University of Plovdiv, 4002 Plovdiv, Bulgaria.

***E-mail** ✉ maria.dimitrova@mu-plovdiv.bg

Received: 27 September 2024; **Revised:** 24 November 2024; **Accepted:** 26 November 2024

ABSTRACT

One well-known technique is gingival tissue retraction. It occurs when the edges of the gingiva move away from a tooth. The quality of periodontal factors affects the marginal fit of a restoration. This systematic review was conducted to determine the effectiveness of diode lasers compared with traditional retraction cords. Databases such as PubMed, Medline, and ScienceDirect were used to conduct a systematic review of the literature encompassing the years 2010–2023. The selection procedure of the searched articles was described using a PRISMA flowchart, and a total of 9 articles were included. It was found that diode laser troughing may be advised if the operator can pay the expense since it delivers adequate vertical and lateral tissue dislocation with less unease, less tissue loss, and more pleased patients than a retraction cord. In individuals with healthy, thick gingiva, laser devices are effective and safe for gingival retraction.

Keywords: Gingival retraction, Retraction cord, Diode laser, Systematic review

How to Cite This Article: Makakova DR, Zagorchev P, Dimitrova M, Georgieva Y, Tilov B. Diode Laser vs. Retraction Cord: Evaluating Gingival Retraction Efficacy in Prosthodontics. Asian J Periodontics Orthod. 2024;4:52-9. https://doi.org/10.51847/PzJumKgace

Introduction

One well-known technique is gingival tissue retraction. It occurs when the edges of the gingiva move away from a tooth [1, 2]. The quality of periodontal factors influences the marginal fit of a restoration [3]. The quality of the impressions is influenced by the location of the finish lines, the state of the periodontal tissue, and sulcus bleeding during impression formation. The several components of gingival retraction have not received much attention, even though it is clear that forcing the end line into the gingival sulcus degrades the quality of the impression [4]. To allow the impression material to be sufficiently thick and to allow access to the impression material outside of the abutment boundaries, gingival retraction helps. The influence of material thickness on the tear resistance of the imprint material may be significant. The prepared tooth surfaces should be exposed by gingival retraction before obtaining an imprint. An imprint with less sulcular breadth is more likely to have voids, rips in the impression material, and a lower marginal precision [5].

Gingival retraction cords were routinely used by 95% of North American dentists, according to research. There are about 125 gingival retraction cords on the market, varying in size, color, and composition. A gingival retraction agent needs to be (1) functional for the desired purpose, (2) secure both locally and systemically, and (3) have spontaneously reversible effects that wear off fast and do not cause tissue displacement [6]. The gingival phenotype may be measured non-invasively using periodontal probe

© 2024 Asian Journal of Periodontics and Orthodontics

transparency, which is also very repeatable, with 85% agreement between records.

The use of lasers in dentistry has recently advanced, and prosthodontics is not unfamiliar with this technique. The behavior of lasers is significantly influenced by the wavelength and waveform characteristics. The diode lasers that are most frequently employed have a wavelength of 980 nanometers (nm). Neodymium: yttrium-aluminum-garnet (Nd: YAG) lasers function at a wavelength of 1064 nanometers. They have less gingival retraction because they bleed less. Scarring preserves gingival margin heights by reducing tissue loss [7]. Connected gingiva may be damaged as a result of the dentists' lack of tactile perception while utilizing lasers for retraction. Because they allow for adequate retraction and hemostasis, take less time to conduct, and don't cause pain to the patient, as an alternative to conventional retraction therapies, soft tissue lasers might be employed [8].

Using the conventional gingival retraction cable technique might cause gingival recession after surgery by damaging the healthy epithelial lining. The recommended time to put the cable into the sulcus is five to fifteen minutes following tooth preparation [9]. Over-tightening the cable or leaving it in place for an extended period might cause a gingival recession. Studies have demonstrated that drugs in the cords may induce gingival inflammation in addition to discomfort and bleeding. Thus, retraction cord-free techniques, such as electrosurgical techniques, have been suggested [10].

Currently, 20% of dentists in the United States utilize lasers for gingival retraction to get the desired impression. Gingival retraction, using Diode, Nd: YAG, Er: YAG, and Er, Cr: YSGG lasers, has been performed [11, 12]. With lasers, the sulcus' epithelial lining is removed without causing harm to the basal cell and connective tissue layers, unlike the retraction cord technique, which shifts gingival tissue. Later on, this could reduce gingival recession. Lasers have been proposed as a substitute for traditional gingival displacement surgery [13].

PICO question

P: Patients undergoing fixed partial denture procedure.
I: Diode lasers
C: Conventional retraction cord
O: Higher impression accuracy and less damage to gingiva

Aims of the study

This systematic review set out to evaluate the effectiveness of diode lasers in comparison to traditional retraction cords.

Materials and Methods

A systematic literature review from 2010 to 2023 was performed using databases such as PubMed, Medline, and ScienceDirect. The keywords used were “gingival retraction”, “retraction cord”, and “diode laser”. PRISMA flowchart was used to describe the selection process of searched articles **(Figure 1)**.

Inclusion criteria

- Case-control and randomized control studies
- Published between 2010 and 2023
- English language of publication
- In vivo (humans)

Exclusion criteria

- Systematic reviews, meta-analyses, expert opinions, or narrative reviews
- Survey-based studies
- Out of the specified time range
- Language other than English
- In vitro

Primary outcomes

To determine if a diode laser is a better option for gingival retraction as compared to conventional methods.

Secondary outcomes

To list down the advantages and disadvantages of both diodes as well as a conventional gingival retraction.

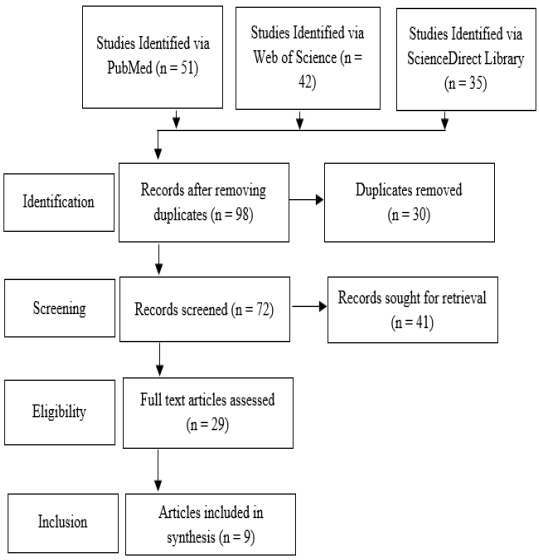


Figure 1. PRISMA flow diagram

Risk of bias assessment

The Cochrane risk of bias assessment method was used to assess the quality of the studies included **(Table 1)**.

Table 1. Summary of Cochrane risk of bias assessment

Reference	Selection bias/appropriate control selection/baseline characteristics similarity	Selection bias in randomization	Selection bias in allocation concealment	Performance-related bias in blinding	Reporting bias/selective reporting of outcomes	Detection bias blinding outcome assessors	Accounting for confounding bias
[14]	+	-	+	+	+	+	+
[6]	+	+	+	+	+	+	-
[15]	+	+	+	+	+	_	+
[16]	+	+	+	+	+	+	-
[8]	+	+	+	+	+	+	+
[17]	+	-	+	+	+	+	+
[11]	+	+	+	+	+	+	+
[18]	+	+	+	+	+	+	-
[10]	+	+	+	-	+	+	+

Results and Discussion

Table 2. Summary of the studies included in the systematic review

Reference	Laser type /technique	Objective	Sample	Follow-up period	Results
Ünalan *et al.* [14]	Cordless paste system, Er, Cr: YSGG laser troughing, and retraction cord	The effects of three gingival dislocation techniques on the periodontal tissues were compared in this clinical study: retraction cord, Er, Cr: YSGG laser troughing, and cordless paste system.	52	1st day, 1st month, 3rd month, 6th month, and 1st year	The PD, GI, and BOP index scores varied significantly among the three surgeries (p = 0.001).
Abdelhamid *et al.* [6]	Retraction cord and diode laser	The two gingival retraction techniques (diode laser and retractable cable) were evaluated in this study for the amount of tissue displacement laterally and vertically.	22		Retraction cable is inferior to the lateral and vertical retraction offered by diode laser troughing.
Gupta *et al.* [15]	Diode laser	The effectiveness of laser-assisted soft tissue treatments and soft tissue management in cosmetic dentistry is evaluated by looking at the results of gingivectomy and gingival troughing.	1	15 days	A successful cosmetic operation with appropriate tissue shape, function, and biocompatibility is guaranteed with dental laser therapy.
Einarsdottir *et al.* [16]	Gingival retraction double-cord method, aluminum chloride paste	This clinical randomized controlled trial (RCTgoal) evaluated the effects of three different gingival tissue displacement techniques on the marginal soft tissue's height.	67	30 ± 10 days	The group differences were not statistically significant (P > 0.05).

Ch *et al.* [8]	Diode lasers	The current study sought to quantify the amount of lateral gingival retraction achieved objectively using diode lasers.	20		The gingival retraction that was achieved was greater than the 200 um minimum required and more in line with the sulcular epithelium's thickness.
Stuffken *et al.* [17]	810 nm diode laser AND mechanical-chemical method with double cords	Using double cords soaked in aluminum chloride and a mechanical-chemical process, this pilot clinical study sought to compare and clinically track gingival tissue regeneration in the same subject using an 810 nm diode laser.	6	1 week, 3 weeks, and 8 weeks	The double cord technique and the laser were found to result in an average gingival height decrease of 0.26 mm and 0.27 mm, respectively, in this study. The severity of the recession was judged to be clinically insignificant.
Tao *et al.* [11]	Er: YAG laser, diode and Nd: YAG lasers, pre-saturated cord	The two most popular methods for gingival troughing, pre-saturated cable, and lasers, were compared in this study.	50	1 week, and after 4 weeks	Compared to lasers, the saturated cord had a significantly higher GR (P = 0.05) and lower gingival sulci. Er: YAG lasers provided the quickest and least disruptive wound healing as compared to diode and Nd: YAG lasers.
Melilli *et al.* [18]	gingival retraction cords (RC) and diode laser (DL)	The study contrasts two techniques for preparing the gingival sulcus: retraction cords and a diode laser.	74	15 days, 10 minutes, 15 days,	DL was faster, easier for the operator, and more pleasant for the patient than RC (all P = 0.001), and the two techniques were equivalent.
Marsch *et al.* [10]	SIROlaser advance / Xtend	In this case study, the gingival troughing preparation borders are seen using the SIROlaser Advance / Xtend.	1	10 sessions per month	The coagulation capabilities of the laser or HF device make it appealing. A laser is without a doubt a better investment from an economic perspective because of its numerous applications.

The overview of all the studies that were part of the systematic review is displayed in **Table 2**. In a clinical investigation, Ünalan *et al.* [14] studied the effects of three gingival displacement methods on the periodontal tissues surrounding a digitally scanned crown repair. The methods examined were the cordless paste system, Er, Cr: YSGG laser troughing, and retraction cord [14]. We measured and analyzed the following: probing depth (PD), sensitivity index (SI), mobility index (MI), plaque index (GI), gingival index (GI), and bleeding on probing (BOP) indices. In the present investigation, 60 mandibular first molars from 52 patients in need of crown restorations (20 men and 32 women) were examined. The margin lines of the crown preparations were placed 1 mm below the gingiva. Patients were divided into three groups based on the gingival displacement method used: Er, Cr: YSGG laser troughing, cordless paste system, and retraction cable. A digital scan of the prepared tooth was performed. Follow-up visits were scheduled at five intervals: daily, monthly, three months, six months, and one year. Six indicators were used to assess periodontal health. The chi-square test was utilized to compare categorical data among the groups. Over the one-year clinical observation period, significant differences were observed in the periodontal pocket depth (PD), gingival index (GI), and bleeding on probing (BOP) scores among the three methods ($P < 0.001$). In the groups that utilized the cordless paste system with a retraction cable, the PD in the three buccal surface areas significantly increased over time ($P = 0.001$).

In their study from 2022, Abdelhamid *et al.* [6] examined the amount of tissue displacement vertically and laterally between the two gingival retraction techniques (diode laser and retractable cable). The candidate's degree of satisfaction as well. We collected twenty-two patients from Cairo University's outpatient clinic who required full coverage porcelain fused to metal fixed prosthesis in the anterior esthetic zone. The gingival retraction method was used to disperse the teeth after they had been polished with a deep subgingival chamfer finish line. The patients in group

I were retracted using a retraction cord. Patients in group II get diode laser retraction. The two groups' lateral and vertical displacements differed significantly from one another. In addition to increasing vertical retraction, laser troughing also results in enhanced lateral retraction. Given the constraints of this investigation, diode laser troughing functions better than retraction cables in terms of both lateral and vertical retraction. The patient reported that laser troughing was less uncomfortable and more pleasant.

To evaluate the data supporting the effectiveness of laser-assisted soft tissue therapies and soft tissue management in cosmetic dentistry, the results of gingivectomy and gingival troughing are analyzed in the case studies governed by Gupta *et al*. [15]. In these case studies, the patients underwent prosthetic rehabilitation of the posterior tooth, esthetic restoration of the carious lesion, and gingivectomy and gingival troughing helped by a 980 nm diode laser to achieve quick hemostasis and moisture control. In both cases, gingival tissues recovered satisfactorily after 15 days. The ability of soft tissue lasers to control moisture and encourage hemostasis appears to be highly promising for practitioners who are excising gingival tissue and using reconstructive techniques for gingival troughing. Dental laser therapy ensures that the tissue is shaped, functioning, and biocompatible for a successful cosmetic procedure.

Einarsdottir *et al*. [16] conducted a clinical randomized controlled trial (RCTgoal) to evaluate the effects of three different gingival tissue displacement techniques on the height of the marginal soft tissue during the final imprinting of a patient's natural teeth. A total of 67 individuals were divided into three groups at random. In test group 1 (P; n = 22), the gingiva was removed using just aluminum chloride paste. In test group 2 (CP; n = 23), aluminum chloride paste was used, and a cord was inserted. The gingiva dislocation in the control group (C; n = 22) was measured using two cords (double-cord technique). The gingival position was clinically measured before therapy started and 10-30 days after the prosthesis was delivered. Research casts, criteria photographs, and graphics editing software were used to assess alterations in the buccal gingival position during the procedure. Gingival recession was more common in group P (8%) than in CP (23%) and C (32%; P = 0.015). 15 (24%) of the subjects reported pain following the procedure. P > 0.05 indicates that the group differences were not statistically significant.

Ch *et al*. [8] conducted research to quantify the volume of lateral gingival retraction achieved using diode lasers. The research concentrated on twenty dental patients who had been suggested to have crowns made after receiving root canal therapy. On twenty teeth, gingival retraction and elastomeric imprinting were carried out. After dividing the models made from the impressions into sections, the lateral distance between the finish line and the marginal gingiva was measured using a toolmaker's microscope. The mean retraction values recorded were 399.5 µm in the mid-buccal area, 445.5 µm in the mesio-buccal area, and 422.5 µm in the disto-buccal area. The amount of gingival retraction achieved exceeded the minimum requirement of 200 µm and approached the thickness of the sulcular epithelium.

Stuffken *et al*. [17] conducted a preliminary clinical trial to compare and clinically evaluate gingival tissue regeneration using a mechanical-chemical technique with double cords bathed in aluminum chloride and an 810 nm diode laser on the same participant. A total of six individuals required two crowns to be installed on their natural teeth for the investigation, and temporary crowns were made following the first session's cleaning of the teeth with a 0.5-mm subgingival completion line. In the double cord procedure, an 810 nm diode laser was used to treat one tooth while two cords impregnated with 5% $AlCl_3$ were used to treat the second tooth. The patients were monitored one, three, and eight weeks after the final crowns were cemented. According to this study, the average gingival height loss caused by the twin cord technique was 0.26 mm, whereas the average loss caused by the laser was 0.27 mm. It was decided that the severity of the recession was not clinically significant.

Pre-saturated cable and lasers, the two most popular methods for gingival troughing (including diode, Nd: YAG, and Er: YAG), were compared in this study by Tao *et al*. [11]. 50 participants with 108 front teeth (50 mandibular and 58 maxillary) participated in this study. Pre-saturated cord, diode laser, Nd: YAG laser, and Er: YAG laser were the four groups that underwent gingival treatment. Gingival recession (GR) and gingival width were assessed at several points in time (at the beginning of therapy, one week later, and four weeks later). Compared to lasers, the GR was significantly higher (P = 0.05) and the gingival sulci were reduced with the saturated cable. Er: YAG lasers provided the quickest and least disruptive wound healing as compared to diode and Nd: YAG lasers.

In their study, Melilli *et al*. [18] compare two techniques for exposing the finish line and prepping the gingival sulcus before obtaining the final impression for a fixed denture: a diode laser and retraction cords. Before receiving fixed prosthesis medications, all subjects in the research had healthy gingival and periodontal tissues. 74 abutments for total crown

restoration were randomized and separated into two groups, using gingival retraction cords (RC) and a diode laser (DL) to realign the gingival sulcus before the final impression. A blinded examiner measured the height of the clinical crowns at three different points on the buccal surface (mesial, midline, and distal) after tooth preparation (T0), 15 days after tooth preparation, before the finish line was exposed with RC or with DL (T1), 10 minutes after the finish line was exposed (T2), and 15 days after the final impression was taken (T3). Regarding height differences, there was no distinction between the two approaches: DL was faster, simpler for the operator, and more pleasant for the patient than RC (all P = 0.001).

The preparation margins during gingival troughing are seen using the SIROlaser Advance / Xtend in the case study reported by Melilli *et al*. [18]. Despite being a relatively small application, the diode laser's ability to perceive the preparation margin through gingival troughing has a big influence on practice efficiency. Ten CEREC (CAD/CAM) sessions are conducted each month, using the diode laser to create an optimal CAD/CAM model. This young patient had lost a large amount of dental hard tissue as a result of damage to the front teeth. Rebuilding the tooth with a composite proved unsuccessful. Overlapping gingival tissues may not be scanned during scanning, which might lead to erroneous impressions. The laser partly damaged the tissue of the mesial papilla, exposing a circular chamfer. After that, an analog and digital imprint was made. The conventional method of using retraction cords and the related coagulants is frequently necessary while creating analog impressions. Because digital scanning has rigorous requirements, only dry surfaces provide a clean image. Therefore, because of its coagulation capabilities, additional equipment such as the laser or HF device is desirable. The pulse mode laser is better than most HF devices because of its gentle action, which encourages faster tissue repair. A laser is without a doubt a better investment from an economic perspective because of its numerous applications.

The epithelial lining of the sulcus can be safely removed with lasers without causing harm to the connective tissue or basal cells underneath. The gingival recession may be reduced as a result. It has been suggested that the conventional cable gingival displacement method may be replaced with lasers [19]. The clinical diagnostic indicators of periodontal health—pocket depth, gingival index, probing depth, mobility, sensitivity, and blood on probing [BOP]—have been found in several studies to be dependable, affordable, and easy to use. However, the author demonstrated that variables such as the tip of the probe, the location and angle of the probe, and the experience of the clinician may add some heterogeneity to the data generated by these indices [20–22]. Since the additional silicone putty enhances gingival tissue dislocation and the firmness of the putty brings light body material into close interaction with the teeth and gingival tissues, a double-step impressions procedure was used in this study to ensure an excellent level of impression precision [23, 24]. Blood loss occurs when a scalpel is used in traditional surgery, which might be an issue if future restorative dental treatment is planned. Electrosurgery can be used to remove gingival tissue safely and with adequate hemostasis. However, this strategy has limitations since it may produce necrosis of the alveolar crest, which leads to recession and reveals the restorative margins [7, 25].

With few negative effects on the surrounding tissue, lasers can enhance operator control. Specifically, diode lasers employ a wavelength that poses less risk to the tooth structure and is easily absorbed by the chromophores (hemoglobin and melanin) in the gingival tissues. The aesthetic result of indirect restoration manufacturing also depends on the impression procedures used. Sufficient moisture management and exposure to the subgingival finish lines are necessary for appropriate imprints. To fully capture the sulcus in the impression material, it is advised to physically move it using the double-cord retraction method [26, 27].

The P and CP test groups in the present study exhibited very few slight irregularities in the finished cast. Even though the polymerization of impression substances may interfere with displacing substances or pharmaceuticals, studies have demonstrated that polyether polymerization can be prolonged when interacting with aluminum chloride. The present study's findings are consistent with an in vitro investigation that found that medications like aluminum chloride and ferric sulfate dramatically reduced the ability to reproduce surface features but had no discernible effect on the dimensional accuracy of PVS impression materials [22].

Diode lasers are being used more and more for soft tissue dental procedures, including peri-implant and periodontal procedures. The study made use of diode laser gingival retraction. Laser surgery has several advantages over conventional therapeutic approaches, including improved hemostasis and patient comfort [28]. The tissue is torn apart by a dragging cutting action when the laser unit's power is reduced, and the preparation's trough's power should increase as the power increases. However, as excessive force results in

tissue necrosis, it should be avoided. Diode laser gingival troughing produced a sulcular width that was more than the required minimum of 0.2 mm. The diode laser impression's dependability was shown in this investigation [29].

Dental treatment is about to become computerized. This supports the use of laser treatment to treat gingival troughing. In many cases, the conventional method of making analog impressions using retraction cords and related coagulants could be sufficient. For the strict requirements of digital scanning, specialist equipment such as a laser or HF device is useful since only dry surfaces provide a clear image. When the laser operates in pulse mode, its gentle action speeds up tissue repair compared to other HF devices. A laser is a better financial investment because of its numerous useful uses [30].

Conclusion

Diode laser troughing may be recommended if the operator can pay the cost since, in comparison to a retraction cord, it provides adequate vertical and lateral tissue displacement with higher patient happiness, less pain, and less tissue loss. Lasers for gingival retraction are effective and safe when applied to those with thick, healthy gingiva.

Acknowledgments: None

Conflict of Interest: None

Financial Support: None

Ethics Statement: None

References

1. Remizova AA, Dzgoeva MG, Tingaeva YI, Hubulov SA, Gutnov VM, Bitarov PA. Tissue dental status and features of periodontal microcirculation in patients with new COVID-19 coronavirus infection. Pharmacophore. 2021;12(2):6-13.
2. Alhamwi N, Al Jarbou F, Ourfhli A, Alfaris F, Algannass T, AlSaffan A, et al. Perception and experience of dental students regarding e-learning education in the universities of Riyadh. Pharmacophore. 2020;11(6):67-73.
3. Asgari I, Soltani S, Sadeghi SM. Effects of iron products on decay, tooth microhardness, and dental discoloration: a systematic review. Arch Pharm Pract. 2020;11(1):60-82.
4. Kannan A, Venugopalan S. A systematic review on the effect of use of impregnated retraction cords on gingiva. Res J Pharm Technol. 2018;11(5):2121-6.
5. Albaker AM. Gingival retraction-techniques and materials: a review. Pak Oral Dent J. 2010;30(2):545-51.
6. Abdelhamid AA, El Mahallawi OS, El Khodary NA. Assessment of lateral and vertical tissue displacement obtained by the retraction cord and diode laser: a randomized controlled clinical trial. Int J Health Sci. 2022;6(S4):1944-59.
7. Gururaj R, Jayesh SR, Nayar S. Comparative evaluation of four factors in gingival retraction using three different gingival retraction techniques: in vivo study. Indian J Public Health Res Dev. 2019;10(12):1190-5.
8. Ch VK, Gupta N, Reddy KM, Sekhar NC, Aditya V, Reddy GM. Laser gingival retraction: a quantitative assessment. J Clin Diagn Res. 2013;7(8):1787.
9. Singh AA, Rao BK, Gujjari AK. Evaluation of gingival displacement using foam cord and retraction cord: an in vivo study. J Int Oral Health. 2019;11(1):8.
10. Marsch A. Use of a diode laser for gingival troughing in conservative and prosthetic dentistry. Int Mag Laser Dent. 2013:30-1.
11. Tao X, Yao JW, Wang HL, Huang C. Comparison of gingival troughing by laser and retraction cord. Int J Periodontics Restorative Dent. 2018;38(4):527-32.
12. Mahjoub HE, Elfallah KI. The knowledge and attitude of using gingival retraction cord in fixed prosthodontics: a survey amongst dental practitioners in Benghazi, Libya. Int J Sci Res. 2023;12(1):1130-5.
13. Safari S, Ma VS, Mi VS, Hamedi M. Gingival retraction methods for fabrication of fixed partial denture: literature review. J Dent Biomater. 2016;3(2):205.
14. Ünalan Değirmenci B, Karadağ Naldemir B, Değirmenci A. Evaluation of gingival displacement methods in terms of periodontal health at crown restorations produced by digital scan: 1-year clinical follow-up. Lasers Med Sci. 2021;36(6):1323-35.
15. Gupta A, Jain N, Makhija PG. Clinical applications of 980 nm diode laser for soft tissue procedures in prosthetic restorative dentistry (case report). J Lasers Med Sci. 2012;3(4):185-8.
16. Einarsdottir ER, Lang NP, Aspelund T, Pjetursson BE. A multicenter randomized, controlled clinical

trial comparing the use of displacement cords, an aluminum chloride paste, and a combination of paste and cords for tissue displacement. J Prosthet Dent. 2018;119(1):82-8.
17. Stuffken M, Vahidi F. Preimpression troughing with the diode laser: a preliminary study. J Prosthet Dent. 2016;115(4):441-6.
18. Melilli D, Mauceri R, Albanese A, Matranga D, Pizzo G. Gingival displacement using diode laser or retraction cords: a comparative clinical study. Am J Dent. 2018;31(3):131-4.
19. Rayyan MM, Hussien AN, Sayed NM, Abdallah R, Osman E, El Saad NA, et al. Comparison of four cordless gingival displacement systems: a clinical study. J Prosthet Dent. 2019;121(2):265-70.
20. Beleidy M, Serag Elddien AM. Clinical comparative evaluation of different retraction systems in gingival displacement and their influence on periodontal health: a randomized clinical trial. Egypt Dent J. 2020;66(3-July (Fixed Prosthodontics, Removable Prosthodontics and Dental Materials)):1667-78.
21. El Driny AM, Salama AA, El-Shal OS, Mohamed MM. Evaluation of the effect of two different activation protocols of periodontal distractor on the periodontal health after rabid canine retraction. Saudi J Oral Dent Res. 2022;7(12):368-75.
22. Dederichs M, Fahmy MD, Kuepper H, Guentsch A. Comparison of gingival retraction materials using a new gingival sulcus model. J Prosthodont. 2019;28(7):784-9.
23. Wang Y, Fan F, Li X, Zhou Q, He B, Huang X, et al. Influence of gingival retraction paste versus cord on periodontal health: a systematic review and meta-analysis. Quintessence Int. 2019;50(3):234-44.
24. Naveen T, Ganapathy D, Visalakshi RM. Retraction systems in fixed partial denture. Drug Invent Today. 2019;12(5):1118-22.
25. Nowakowska D, Raszewski Z, Saczko J, Kulbacka J, Więckiewicz W. Polymerization time compatibility index of polyvinyl siloxane impression materials with conventional and experimental gingival margin displacement agents. J Prosthet Dent. 2014;112(2):168-75.
26. Nain VJ, Beniwal J, Tiwari D, Dahiya D, Reshmi RV. Clinical comparison of the efficacy of magic foam cord retraction system and medicated retraction cord impregnated in ferric sulphate on the basis of relative ease of working, hemorrhage control and amount of vertical gingival retraction: an in vivo study. Natl Res Denticon. 2020;9(1):1-13.
27. Coelho DH, Cavallaro J, Rothschild EA. Gingival recession with electrosurgery for impression making. J Prosthet Dent. 1975;33(4):422-6.
28. Sampath P, Varma L, Varma M, Shabu A. Recent advances on gingival tissue management in restorative dentistry. Ind J Dent Sci. 2019;11(4):185.
29. Benson BW, Bomberg TJ, Hatch RA, Hoffman Jr W. Tissue displacement methods in fixed prosthodontics. J Prosthet Dent. 1986;55(2):175-81.
30. Sorrentino R, Ruggiero G, Zarone F. Laser systems for gingival retraction in fixed prosthodontics: a narrative review. J Osseointegration. 2022;14(1):1-5.