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Assessment of lateral and vertical tissue displacement obtained by the retraction cord and diode laser: A randomized controlled clinical trial

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Abstract---This study was carried out to compare between two techniques of gingival retraction (retraction cord and diode laser) regarding the amount of tissue displacement both laterally and vertically. Also, Patient satisfaction during their application. Methodology: twenty two cases requiring full coverage porcelain fused to metal fixed prosthesis in the anterior esthetic zone were taken from the outpatient clinic of the fixed prosthodontics department – Cairo University. The teeth were prepared with subgingival deep chamfer finish line and were distributed according to the technique of gingival retraction. Group I: Patients receiving retraction with the retraction cord. Group II: Patients receiving retraction with diode laser. In both groups measurement of lateral and vertical displacement done by using the stereomicroscope. also, patient satisfaction was measured by Comley and Demeyer numeric pain scale. There was significant difference between the two groups regarding lateral and vertical displacement. Laser troughing give not only more amount of vertical but also more lateral retraction whereas, $P < 0.05$. For the patient satisfaction there was a significant difference between both groups, with laser troughing give better results. Within the limitations of this

study, diode laser troughing gives more amount of retraction both laterally and vertically when compared to retraction cord. Laser troughing was more satisfactory to the patient and produced less pain.

Keywords---diode laser, retraction cord, gingival displacement, gingival retraction.

Introduction

Meticulous handling of the gingival tissues is a must to maintain proper health of the gingiva and periodontium, prevents trauma to the gingiva during preparation with subsequent gingival bleeding, also it prevents violation of the biological width and prevents gingival recession. Proper retraction of the gingiva helps for proper positioning of the finish line during preparation which is very important specially at esthetic zones when finish line is supposed to be sub gingival. The finish line must be smooth and continuous for proper seating of restoration to prevent marginal discrepancy and dissolution of cement with lossness of the restoration. [1].

For impression procedures, it is urgent to gain about 0.15-0.2 mm gingival dilation in the lateral direction to allow light body material to flow easy around the finish line to get impression without voids and avoid tearing of the impression upon removal also about 0.5mm below the finish line should be exposed to capture the emergence profile. [2]. Different means and techniques are available for retraction either mechanical, chemicomechanical or surgical, new products are available nowadays giving amount of retraction similar to the retraction cord with less time consuming, more comfort to the patient, less damage to the gingiva during the retraction procedure and more recovery and regeneration of epithelium after retraction. Whatever the technique it must be effective for its selected use, not harmful both local and systemic and the effects must be spontaneously reversible, with no permanent tissue damage. [3]. So, this study was carried out to evaluate which technique of gingival displacement (retraction cord and diode laser) give more amount of gingival retraction laterally and vertically with more patient satisfaction.

Participants and Methods

Sample size calculation and sample grouping

Sample size calculation was performed using G Power version 3.1.9.21. Independent t-test was used to detect the proper sample size, mean and standard deviation were used to detect the amount of lateral gingival displacement according to Thimmappa, Meenakshi et al (2018) and by adopting an alpha (α) level of 0.05 (5%) and Beta (β) level of 0.20 (20%) i.e. power=80% and an effect size (d) of (1.47). The predicted sample size (n) was a total of (18) cases i.e. (9) for each group. Sample size was increased by (25%) to be a total of (22) cases i.e. (11) for each group.

Research ethics approval

This study and the template informed consent form reviewed by the Ethics Committee of Scientific Research - Faculty of Dentistry – Cairo University, and approved in July 2019.

Study design

This study was performed in Fixed Prosthodontics Department clinics of Faculty of Dentistry, Cairo University, Cairo, Egypt. Twenty two teeth requiring full coverage porcelain fused to metal fixed prosthesis in the anterior esthetic zone. The teeth were prepared with subgingival deep chamfer finish line and were distributed according to the technique of gingival retraction.

Randomization

Randomization to the groups was done through computer generated software (www.randomizer.org). A participant blinded to the randomly generated sequence was responsible for placing the patients into sealed and sequentially numbered envelopes. The person responsible for sequence generation allocated the numbered envelopes to their intervention groups as determined by the random table. Researcher received written consent from patients willing to participate in the trial. All consent forms were supplied in Arabic language. The consent was explained verbally and with written instructions.

Methods

Patient preparation

Each patient has under gone scaling, polishing and oral hygiene instructions before work. Medical history and dental history were taken for each patient then extra and intraoral examination was carried out, periapical x-rays as well as study casts were also obtained.

Intraoral Examination of the Abutments Gingival biotype determination

Gingival biotype was determined by putting the periodontal probe in the buccal sulcus of the abutment and see if its shadow was seen through the gingiva then it is considered as thin gingival biotype, if not then it is of thick gingival biotype, only thick gingival biotypes were included in the study. [4]

Checking mobility of the abutments

The abutments were checked for mobility by applying the handle of a dental mirror at one side of the tooth and another hard instrument from the other side then the degree of mobility was determined according to Miller's classification, who classified tooth mobility into 3 categories.

- Grade I: Normal physiologic tooth movement

- Grade II: Deviation of the tooth crown 1 mm in a bucco-lingual direction.
- Grade III: Tooth depressed in the socket. [5]
- Only grades I and II were included in the study.

Bleeding on Probing test

Bleeding on probing test was done according to Mombelli et al. (2004) by passing the periodontal probe circumferentially along the mucosal margins of the tooth and categorize the condition according to the following grades:

- If no bleeding, it was considered grade 0
- If only isolated bleeding spots, it was considered grade 1 3- If red line on mucosal margin considered grade 2
- profuse bleeding on probing considered grade 3 [6]
- Only the first 2 grades were included in the present study.

Mucosal condition examination

Mucosal condition was evaluated by subjective visualization assessment according to the scores specified by Apse et al. (2014)

- 0-Normal mucosa
- 1-Minimal inflammation with color change
- 2-Moderate inflammation with redness, edema
- 3-Severe inflammation with redness, edema, ulceration and spontaneous bleeding without probing. [6] Only the first 2 scores were included in the present study

Sulcus depth determination

The probe was inserted parallel to the long axis of the tooth and moved along the tooth margin. The probing depth was measured from the free gingival margin to the deepest penetration of periodontal probe in millimeters. The sulcus depth of 1.5-2 mm was selected in the study [7]

Full arch impression making

A Putty index was taken before preparation with polyvinyl siloxane impression material for the desired teeth using a stock tray, equal amounts of base and catalyst were mixed and loaded in the tray and inserted in the patient's mouth till complete setting according to the manufacturer's instructions.

Teeth preparation

Infiltration anesthesia was given and teeth preparation was done by using a tapered stone with round end size 13 to obtain first a 0.5 mm subgingival deep chamfer finish line with thickness of 0.8-1 mm to receive PFM restoration with an incisal reduction of 1- 1.5 mm and axial reduction of 1.2 - 1.5 mm and a facial reduction in two planes of 1.4 mm - 1.7 mm. [8], [9]

Pre displacement impression making

Impressions were taken using double mix / 2 step technique using polyvinyl siloxane impression material. The first step involved taking a preliminary impression in a stock tray with the Putty material, the second step was to take the final impression with a light body wash material.

Retraction Procedures with Ultra-pack retraction cord

For Group I that received retraction by the retraction cord, first the proper size of the retraction cord was chosen based on the depth of the sulcus. The finish line was placed 0.5mm below the gingival margin if the sulcus depth probe was 1.5 mm or less. The margin was positioned half the depth of the sulcus if the sulcus depth was greater than 1.5 mm. If the sulcus depth was greater than 2mm, gingivectomy was performed to generate a 1.5mm sulcus depth and a 0.5mm gingival margin. [10] In the present study it was placed 0.5mm below the gingival margin. After that the retraction cord was packed by a smooth cord packer starting from mesial side along the whole surface of the tooth buccally, distally and then lingually. Packing of the retraction cord was done gently to avoid tearing to the periodontal ligaments. The retraction cord was left for 10 minutes in the sulcus then removed. [11] The sulcus was rinsed carefully to remove any debris of the cord and the medicament, then air dried.

Retraction Procedures with diode laser

The diode laser was used to begin the operation, which was set to a continuous wave of 2 W. Tissue charring, an adverse result, would occur if the laser was utilised with too high power or the tip was moved too slowly. [12] The sulcular epithelium was removed by passing the optic fiber tip along the gingival sulcus, directed toward the soft tissue and away from the prepared tooth. To create a full 360-degree trough, use consistent and steady short brushing strokes to carefully remove the lining of the sulcus. The fiber tip was inserted into the crevicular sulcus in the same way like the conventional scalpel with a circular movement around the tooth. [13], [14] To remove debris and eliminate bacterial contamination, the tip was cleaned on a regular basis with a gauze sponge soaked in hydrogen peroxide. Enough epithelium was removed to allow the impression material to be placed and the finishing line to be visualised. During the operation, the tissue was kept wet with water. [12]

Post displacement impression making

For both groups, after gingival displacement the light body addition silicone was injected into the sulcus and around the prepared tooth and the wash was injected in the putty index taken before preparation, the tray was held in the patient's mouth till setting of the impression material then removed.

Disinfection of the impression

The impressions were disinfected using 0.5% sodium hypochlorite for 10 minutes. After that the impressions were rinsed with water and kept in refrigerator. [15]

Pouring the impression

The impressions were poured with type IV dental stone to produce the working cast with removable die. then, the master casts were used for measuring the sulcus depth and width before and after gingival displacement.

Measurement analysis

The mesiodistal width of each die was measured in order to approximate the cutting plane at midlabial and the transitional line angles to points similar to that selected on the die before and after retraction. The cast was fixed into a custom made holder and three points on the desired die were determined for measurement which are: the mid buccal and the transitional line angles mesially and distally and the dies were left without ditching to not remove gingiva. [11] The pre and post retracted dies were sawed at the mentioned points then under the stereomicroscope x (10 Magnification), the sulcus width was measured between the surface of the tooth and the gingival margin at the 3 points mentioned above for both the pre and post retracted dies to calculate the amount of lateral gingival displacement. Also, the vertical displacement was calculated by measuring the amount of vertical length from margin of the gingiva coronally to the bottom of the sulcus for both the pre and post retracted dies under the stereomicroscope and by subtraction the amount of vertical displacement was calculated. [16]

Assessment of pain intensity during retraction procedures

In both procedures the patient was asked to fill a pain scale from 0 - 5 according to Comley and demeyer table (1) to assess the pain severity during the application of both retraction materials. [17], [33]

Table 1
Comley and demeyer scale

0	1	2	3	4	5
No	Mild	Discomforting	Distressing	Intense	Excruciating

Statistical analysis

Statistical analysis was performed using SPSS 20®, Graph Pad Prism® and Microsoft Excel 2016. Data was represented as mean and standard deviation. Data were explored for normality by using Shapiro Wilk and Kolmogorov-Smirnov normality test which revealed that all data were parametric data (P-value > 0.05). Accordingly, comparison between pre- displacement records and post-displacement records was done by using Paired T-test. While for two groups comparison.it was done by independent t test. Also, three sides comparison within the same group was performed by using One Way analysis of Variance (ANOVA) test followed by Tukey's post hoc test for multiple comparisons

Results

Vertical tissue displacement

Comparison between both groups regarding vertical displacement group I was significantly lower than group II regarding pre-displacement, post-displacement, and difference between them in mid-Buccal and mesial and distal surfaces as presented in table (2) and figure (1)

Table 2

Comparison between group I & II regarding vertical displacement in all surfaces in pre displacement record, post displacement record and difference between them:

Vertical tissue displacement		Group I		Group II		P value
		M	SD	M	SD	
Mid. Buccal	Pre	0.168	0.06	0.52	0.11	0.0001*
	Post	0.367	0.123	1.301	0.36	0.0001*
	Difference	0.199	0.077	0.781	0.25	0.0001*
Mesial	Pre	0.236	0.09	0.462	0.14	0.0002*
	Post	0.465	0.195	0.75	0.15	0.0001*
	Difference	0.228	0.119	0.288	0.01	0.0003*
Distal	Pre	0.185	0.09	0.480	0.147	0.0001*
	Post	0.393	0.141	0.756	0.14	0.0002*
	Difference	0.207	0.152	0.276	0.007	0.005*

M; mean

SD; standard deviation

*significant difference ($P < 0.05$).

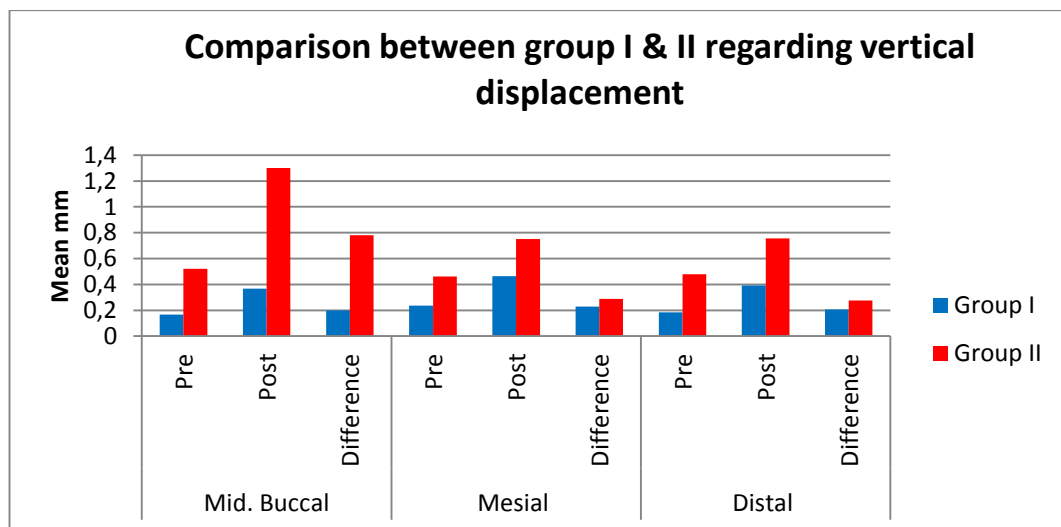


Figure 1. Bar chart represents comparison between group I & II regarding pre, post and difference displacement records of mesial, mid. buccal and distal surfaces

Lateral tissue displacement

Comparison between both groups regarding lateral displacement was performed and revealed that, in prerecords Group I was higher than group II, in post records Group I was significantly lower than group II, while in difference also group I was significantly lower than group II, as presented in **table (3)** and **figure (2)**.

Table 3

Comparison between group I & II regarding lateral displacement in all surfaces in pre displacement record, post displacement record and difference between them

Lateral tissue displacement		Group I		Group II		P value
		M	SD	M	SD	
Mid. Buccal	Pre	0.137	0.06	0.111	0.05	0.01*
	Post	0.382	0.226	0.654	0.185	0.001*
	Difference	0.245	0.166	0.543	0.135	0.0001*
Mesial	Pre	0.183	0.09	0.156	0.06	0.05*
	Post	0.399	0.122	0.578	0.146	0.0001*
	Difference	0.216	0.032	0.422	0.086	0.0001*
Distal	Pre	0.185	0.09	0.123	0.06	0.0001*
	Post	0.375	0.178	0.519	0.198	0.0001*
	Difference	0.19	0.088	0.396	0.138	0.0001*

M; mean

SD; standard deviation

*significant difference ($P < 0.05$).

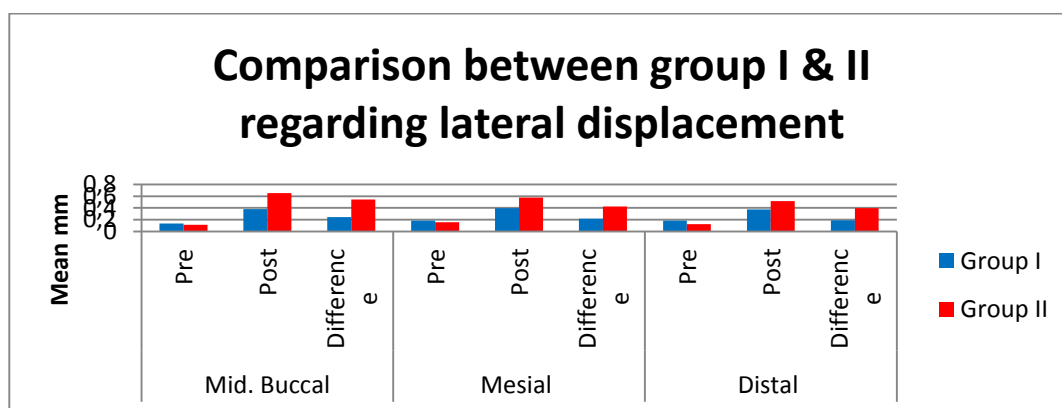


Figure 2. Bar chart represents comparison between group I & II regarding pre, post and difference lateral displacement records of mesial, mid. buccal and distal surfaces

Patient satisfaction

In group I, regarding Pain scale, minimum was 0, maximum was 4 and mean $\pm$ standard deviation was 2 ± 0.95 . In group II, minimum was 0, maximum was 2 and mean $\pm$ standard deviation was 1 ± 0.47 . Comparison between both groups was done by using Independent T-test which revealed significant difference between them as $P < 0.065$ as presented in table (4) and figure (3).

Table 4
Patient satisfaction in group I & II

	Min.	Max.	M.	SD	P value
Group I	0.00	4.00	2.0	0.95	0.003*
Group II	0.00	2.00	1.0	0.47	

Min; minimum

Max; maximum

M. mean

SD; standard deviation

*significant difference as $P < 0.05$

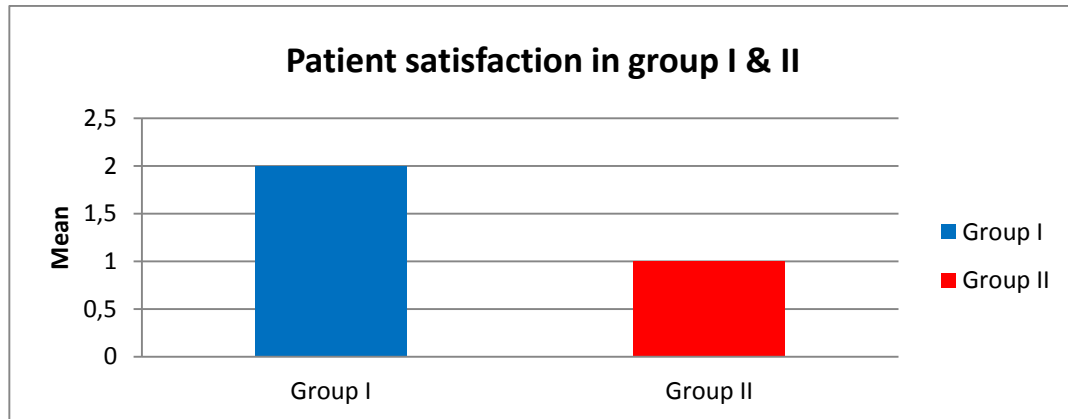


Figure 3. Bar chart represents pain of both group I & II

Discussion

The first point to discuss in this study is the importance of gingival displacement. gingival displacement is one of the important phases in fixed prosthodontics starting from the diagnosis of the abutment teeth as sometimes there are carious or non-carious cervical lesions that may be located at or below the free gingival margin that needs gingival displacement to be diagnosed and treated. During tooth preparation gingival displacement is needed specially when the finish line is located at or below the gingival margin to ensure finish line will be smooth and continuous for proper seating of restoration to prevent marginal discrepancy and dissolution of cement with lossness of the restoration. [18] During impression making tissue management is a critical aspect. Regardless of whether the impression is made conventionally or digitally, all tooth preparation margins must be recorded in the impression to provide a great marginal adaptation of the final restoration. In cementation procedures gingival displacement is needed to clinically visualize the marginal fit and adaptation of the restoration to the tooth. From this, the final restoration will be adapted well to the tooth preparation so that when recurrent caries, tooth sensitivity and gingival irritation will not occur. No matter what the circumstance for soft tissue management are, the goal for management of gingival tissues requires that the periodontium be in a state of health. [19]

During impression making, the amount of lateral displacement must exceed 0.15-0.2 to allow proper flow of the impression material in to the gingival sulcus to avoid tearing of the impression during removal or having impression with voids,

and amount of vertical displacement must be about 0.5mm below the finish line to expose portion of the unprepared tooth below the finish line. [20]. This study was carried on 22 cases need full coverage PFM restoration in the anterior esthetic zone on patients enrolled from the outpatient clinic in Fixed Prosthodontics clinic, Faculty of Dentistry, Cairo University according to the following criteria.

Age range was arranged to be from 20 to 45 years to include wide range of age. The abutments were selected to be periodontally healthy as inflamed tissues are periodontally unstable and are prone to bleeding and collapse during making impression. [21] Patients with thick gingival biotype were selected because they are less likely to have recession as they have wide band of keratinized gingiva. Unlike thin gingival biotypes, which have a thin zone of keratinized tissue and are more vulnerable to damage, leading in recession due to over reaction of tissues so they need meticulous handling of gingival tissues and as we are in esthetic zone and the restoration was ceramometallic so thick gingival biotypes only were selected to avoid esthetic failure by time or showing of the greyish margin of the restoration through the thin gingival biotypes. [11] Pregnant women were not included in the study as they have hormonal changes and increased vascularity and this lead to high inflammatory response, vascular flow, cellular changes, changes in oral biofilms. [22] Smokers were also excluded because smoking lead to increase in pocket depth, loss of clinical attachment, reduction in inflammatory response which affects the response of the gingiva to healing after retraction procedures. [23]

This study was a randomized clinical trial, where randomization was carried out by using computerized Sequence generation (www.randomizer.org) to eliminate the risk of selection bias of the included patients. Teeth were prepared with tapered stone with round end size 13 to give a sub gingival deep chamfer finish line as the restoration was ceramometallic made with the layering technique and deep chamfer finish line is less likely to have undercuts and more conservative than shoulder finish line. [24]. Teeth were prepared according to the glossary of prosthodontics principles with uniform anatomical occlusal preparation of 1- 1.5 mm and axial reduction of 1.2- 1.5 mm [8] and a facial preparation between 1.4 mm and 1.7 mm to have a life like appearance [24]

Ultra-pack knitted impregnated retraction cord was used because it is the gold standard method of retraction, It is made of 100% cotton, doesn't entangle in diamond bur, has bright color that facilitates easy packing and removal and stays in place without fraying, the knitted one is selected over twisted or braided. The knitted cord composed of thousands of tiny loops to form long, interlocking chains. [10]. The knitted design of the ultra-pack cord has the advantage of exerting a gentle, outward force after placement upon wetting it will widen the gingiva more than the perimeter of the cord, giving rapid tissue displacement, detailed margins, and quality impressions. Optimal tissue displacement occurs in 3-8 minutes. In a study by Jokstad et al. (1999) it was shown that knitted cord showed better gingival displacement than braided or twisted. [10]

Impregnated retraction cord is selected as it has better ability to arrest

hemorrhage, crevicular fluid flow and decrease rebound of the crevicular gingival fluid after removal than plain cord as stated by Csillag et al (2007). [21]. Diode laser was used as a substitute for conventional method of gingival retraction as the cord packing can harm the healthy epithelial lining of the sulcus, leading to gingival recession. Gingival recession can occur if the cord is left in place for too long or with too much force. In addition to discomfort and bleeding, gingivitis has been reported due to medicaments in the cords [25]. TNF- level increases after cord packing causes injury to Sulcular epithelium and connective tissue attachment, according to [26], and complete clinical recovery occurs within 2 weeks. [2]

The epithelial lining of the sulcus is removed by laser without endangering the basal cell and connective tissue layers. This may minimize gingival recession. From this point, lasers have been suggested as alternative to conventional cord gingival displacement method. [12] In a histologic specimen, Gabbar and Aboulazm (1995) discovered that laser gingival troughing resulted in faster healing (within two weeks) and less inflammation than the traditional presaturated retraction cord. Gingival troughing with a diode laser achieves excellent hemostasis and moisture management. [27] When compared to magic foam cord (85 s) and retraction cord (56 s), diode laser also has the least time-consuming gingival retraction (mean value = 56 s) (252 s). [13]

For impression making, double step impression technique was applied in this study as the addition silicone's putty provides greater gingival tissue displacement, and the stiffness of the putty allow light body material to be forced to become in close contact with the teeth and gingival tissues to ensure a high impression accuracy. [11]. Automixing dispensing gun was used for light consistency to ensure homogenous mixing of base and catalyst and avoid air trapping during the mix. [28] Amount of lateral and vertical dilation were calculated by using a stereomicroscope like to the method applied by Bowles et al (1991) as it is a convenient method, used in many studies, allows examination in 3-D dimensions. [1] However, the sulcus depth can be measured by using the periodontal probe, but this method is invasive and causing patient discomfort. [28] For lateral and vertical measurements, the mid buccal point and two locations at the transitional line angles were chosen as measuring points. Due to anatomic and micro structural changes at the transitional line angles and mid buccal gingiva, the closure patterns of the two locations differ mesially and distally. The gingiva is thicker and richer in collagen fibers interproximally than the buccal area. The transitional line angle is the point where the dentogingival and semicircular fibers meet the transgingival fibers that come from the neighbouring tooth. Furthermore, the thick alveolar bone in this area produces thicker alveologingival fibers than in the mid buccal region. [10] And this was in agreement with lauffer et al (1997) who reported that the sulcus remains open for a longer period at the mid buccal point. [8] Also, Chandra et al (2016) when compared between cord and cordless means of retraction he found that the closure rate of the widened sulcus was more at the transitional line angles than the mid buccal and the cordless group showed inadequate sulcus width after 1 minute at the mid buccal and after 40 seconds at the transitional line angles. [29] Also, the gingival fibers at the line angles are stiffer and more resistant to retraction so we need to know if the retraction strategy used in the study will give

sufficient retraction along the whole surface of the tooth. Dies were left without ditching to preserve the gingival tissue as measurements are taken from the tooth surface to the gingival margin both laterally and vertically.

Paired T- test was used to compare the pre and post displacement values within the same group followed by the independent T-test to compare between lateral and vertical displacement between the two groups, the Oneway Anova test was followed by the Tukey's post Hoc test for detailed Comparison of each selected area on the same surface. Results of the retraction cord group both the vertical and lateral gingival displacement have a significant difference between the pre and post retraction values for each point selected and this is due to the efficient action of displacement by the retraction cord. There was a significant difference for the amount of pre and post displacement record between the three points selected regarding vertical retraction. when we go for lateral displacement, there was a significant difference in pre and different displacement record between the three points selected which is attributed to the anatomical structure of the gingival fibers as the fibers around the transitional line angles are more stiff and more resistant to displacement and that is similar to the results of laufer et al (1997). [21]

While for the laser group also there was a significant difference between the pre and post retraction values for both the vertical and lateral displacement values which means that the diode laser is an effective mean of retraction by removing the inner epithelial lining from the sulcus. By comparing the two groups the diode laser gives more vertical and lateral gingival displacement than the ultra-pack retraction cord with significant difference between them both vertically and laterally and this may be due to the fact that gingival troughing by laser systems can reach to 0.23-0.67 mm, which is similar to the thickness of sulcular epithelium and higher than the 0.20 mm required for retraction. [13] These findings were also with Goutham GB et al. (2018) study who found diode laser give greater gingival displacement laterally than magic foam cord, and retraction cord impregnated with aluminum chloride. [3] This in agreement with Tao et al. (2018) study who found gingival troughing using dental lasers resulted in better gingival displacement, less gingival recession, less inflammation, and more patient satisfaction when compared to conventional retraction cord method. [12] This study also confirmed by Goutham GB (2018) who found laser produce more sulcus width (mean value 0.48 ± 0.101 mm) than retraction cord method (mean value 0.44 ± 0.11 mm). [3]

The amount of gingival retraction achieved using gingival retraction cords or the diode laser technique is equivalent, but the diode laser took less time, was easier for the operator, and was more comfortable for the patient than the retraction cords. [30] This study also is not in agreement with Gururaj R (2019) study who found retraction cord give more lateral and vertical gingival displacement than diode laser but laser gingival troughing occur with less time and more hemorrhage control than retraction cord method. [31]. For patient satisfaction there is a clear difference between the cord and laser with the laser group more satisfactory to the patient due to elimination of the retraction force by the operator, a numeric scale from (0-5) was used according to Comley & DeMeyer (2001) instead of 0-10 points and that was with the recommendations of a physician consultant from

the Pain Management Center. [17]

Retraction cord produces the correct retraction, according to Phatale et al. (2010), although packing the cord is difficult. Physical pressure on the tissue is required, resulting in gingival bleeding. As a result, using the cord approach carries the danger of epithelial attachment injury, pain during cord packing, which normally necessitates local anaesthetic, and is also time consuming. [32] This study also confirmed by Sorrentino R et al. (2021) study, which said that the laser gingiva displacement seems to be relatively painless and improving patient comfort. [13]

Conclusions

Within the limitations of this study, the following can be concluded:

- Diode laser produced higher gingival displacement both vertically and laterally when compared to the ultra-pack knitted retraction cord.
- Both the ultra-pack knitted retraction cord and the diode are an effective means of retraction as they give the minimum amount of retraction needed both horizontally and vertically.
- Laser troughing was more satisfactory to the patient and produced less pain in comparison to retraction cord application.
- Diode laser could be an alternative to the retraction cord technique in cases of thick gingival biotype.

Recommendations

Recommendations for further investigations

Further studies may be needed with increased sample size, more studies are needed to show the effect of finish line design and position on the selection of retraction technique and material, Sulcus depth variations should be eliminated to decrease confounders, more studies can be done by measuring the amount of tissue dilation by using intraoral scanner instead of conventional impression to eliminate the variation due to impression material inaccuracy, the die material flow and eliminate any variations during cast construction, Profile projector can be used as a measuring tool.

Recommendations for general practitioners

Diode laser troughing may be recommended as long as the operator can afford its cost as it provides sufficient amount of vertical and lateral tissue displacement with more satisfaction to the patient less pain and less tissue destruction. When utilised for gingival retraction, laser systems are effective and safe when employed on patients with healthy thick gingiva.

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