

Comparative evaluation of three gingival displacement systems: an *in-vivo* study

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Abstract. – OBJECTIVE: The study aimed to evaluate and compare gingival retraction in terms of lateral and vertical displacement with a magic foam cord, conventional retraction cord, and laser.

PATIENTS AND METHODS: This *in-vivo* experimental study was performed on 60 patients. Three different gingival retraction systems were used to evaluate the amount of vertical and lateral displacement. The study sample units were divided into three groups of 20 units each. Tooth preparation was done for a metal-ceramic restoration with a subgingival finish line. Gingival displacement was accomplished with a magic foam cord, conventional retraction, and laser. Vertical and Lateral displacement was measured by the distance from the finish line to the free gingival margin in pre and post-displacement casts with the help of a traveling microscope. Stereomicroscopic images of the impression of $\times 10$ resolution were scanned into an image analyzer to measure the lateral displacement. The data analyzed using one-way ANOVA and Bonferroni test were used to determine the significant difference at the $p < 0.05$ level.

RESULTS: Independent group analysis comparing the vertical and lateral displacement within each group showed a statistically significant difference ($p < 0.05$) with mean maximum vertical and lateral displacement achieved by lasers (0.73 and 0.61) followed by magic foam (0.37 and 0.21) and least by retraction cord (0.21 and 0.13), respectively.

CONCLUSIONS: Laser provided the maximum lateral and vertical displacement of the gingival margins, followed by magic foam cord, and the least with conventional retraction, which was statistically significant.

Key Words:

Fixed dental prosthesis, Gingival retraction, Gingival sulcus, Subgingival finish line, Tooth preparation.

Introduction

It is essential to obtain deflection of the gingival tissue while doing tooth preparation in fixed prosthodontics to attain proper margins and ap-

propriate moisture control while making the impression¹⁻³. Proper gingival retraction helps the impression material flow beyond the gingival margin, ultimately affecting the success of the restoration's definitive outcome concerning the accuracy, margins, and bulk of the restoration^{4,5}. The glossary of prosthodontics terms defines gingival displacement as displacement of the marginal gingiva away from a tooth^{6,7}. A well-adapted and smooth gingival margin help maintain a healthy periodontium. Lateral retraction displaces the tissues so that an adequate bulk of impression material can be interfaced with the prepared tooth. Vertical displacement is necessary to expose the tooth's uncut portion of the apical to the finish line⁸⁻¹⁰. Gingival deflection techniques are further categorized as mechanical, chemical-mechanical, electrosurgical, and rotary curettage, or a combination of these techniques¹¹⁻¹⁵. Amongst these methods, impregnated and non-impregnated retraction cords are most commonly used. These retraction methods are technique sensitive and lead to trauma to the gingival tissue, eventually introducing newer retraction techniques¹⁶⁻¹⁹.

Magic foam cord (Colte'neWhaledent AG, Altstatten, Switzerland) is made of polyvinyl siloxane. This material expands on being injected into the sulcus in gel form; the setting reaction releases hydrogen gas and becomes an expanded foam, thus deflecting the free gingival margin away from the tooth to achieve gingival displacement²⁰. Soft tissue lasers can also be used as a substitute for conventional retraction techniques. Lasers have been increasingly used for many soft tissue dental procedures, which include soft tissue surgeries²¹. Periodontal and peri-implant surgeries because they provide adequate retraction along with hemostasis, with less working time and good patient comfort^{22,23}. The study aimed to determine an appropriate gingival displacement system using a laser, magic foam cord, and plain retraction cord.

Patients and Methods

Sample Size and Study Participants

The institutional review board, Majmaah University, AlMajmaah, Saudi Arabia, approved the study under IRB No. MEU-Dec-27/COM-2020/16-3. This randomized clinical study was done per CONSORT guideline (2010)²⁴. It was carried out on 60 patients aged 18-35 years visiting the Department of Prosthodontics with missing anterior maxillary teeth or endodontically treated maxillary anterior teeth. All the participants were taken randomly, the participants were explained about the study, and consent was obtained. Approval from the ethical committee was obtained prior to the start of the study. All the participants were distributed randomly into study groups. The methods selected for gingival retraction were magic foam cord, retraction cord, and laser, including group A (20), group B (20), and group C (20), respectively. Patients with thick gingival biotypes were assessed by the probe transparency method Patient's gingival and periodontal status were examined according to the Loe index and Periodontal Treatment Need Index. Abutment teeth of normal anatomy and morphology were selected for the study^{25,26}.

Inclusion Criteria

- Patients with Clinically and Radiographically healthy gingiva and periodontium around the abutment.
- Thick gingival biotype.
- Loe and Silness index²⁵.
- Periodontal index and treatment needs index²⁶.

Exclusion Criteria

- Pernicious oral habits.
- Hormonal imbalance.
- Immunocompromised.
- Debilitating pre-existing systemic conditions like cardiovascular diseases.

Retraction Methods

After the tooth preparation was carried out following retraction techniques were used on the patients as per random distribution into the groups:

Retraction cord

The retraction cord of adequate size/width and length was cut and looped around the prepared tooth. Cord packing was started from the mesial interproximal area by gently pushing the cord into the sulcus. After 5 min, the cord was removed²⁷.

Magic foam

The magic foam cord cartridge was attached to the auto-mixing gun. Then the mixing syringe with an intraoral tip was placed inside the gingival sulcus, and gingival retraction material was applied all around the tooth. After injecting the retraction material, the corresponding compare-cap was placed onto the abutment to push the material deep into the gingival sulcus. After 5 min, the compare cap with the set retraction material attached was removed from the patient's mouth²³.

Laser

The soft-tissue diode laser was used to achieve the desired margins around the crown preparation. It was set to produce 1.4 W at a continuous wave with an initiated tip. Once the tip was fully initiated, it was placed approximately 1 mm subgingivally between the tissue and the bone. The laser's tip is placed into the gingival sulcus in a manner parallel to the tooth's long axis. Light brush strokes dispose of heat and allow the laser to vaporize the tissue. As it troughs around the margins of the tooth, the laser achieves complete and adequate retraction quickly yet safely²⁸⁻³⁰.

Preparation of the cast

Pre-retraction impression was made using additional silicone impression material in stock trays with the putty wash technique. The cast was obtained by pouring the impression with type IV die stone material. Post-retraction impression was made using additional silicone impression material in stock trays with a putty wash technique. Both the casts of the same patient were evaluated for the displacement of the gingival margin in the lateral and vertical direction. The prepared tooth was marked with a pencil in the midline mesiodistally. With the help of a circular saw, the tooth was sectioned into two halves. These sectioned casts were then placed on the traveling microscope, where the lateral and vertical displacement of the gingival margins were recorded. A single prosthodontist performed all the procedures.

Statistical Analysis

Inter-group comparison for vertical and lateral displacement by three gingival retraction methods was made using the one-way ANOVA-test. Multiple pairwise comparisons were made using Bonferroni's Post hoc test. Descriptive analysis was done to obtain each group's mean and standard deviation. An Independent *t*-test was done to compare the vertical and lateral displacement within the individual groups. A *p*-value <0.05 was considered statistically

significant. Statistical analysis was done using IB, SPSS for Windows, Version 16.0. (SPSS Inc., Chicago, IL, USA) and results were evaluated.

Results

A total of 60 participants were enrolled in the study. Conventional (0.132 mm) had less lateral displacement compared to magic foam (0.31 mm), and laser methods (0.61 mm) (Figure 1), and comparison showed statistically significant ($p < 0.05$). Similarly, Conventional (0.212 mm) had less lateral displacement than magic foam (0.37 mm). Laser methods (0.73 mm) and comparison showed statistically significant ($p < 0.05$) and this difference was statistically significant (Figure 2). One-way independent group analysis comparing the vertical and lateral displacement within each group showed significant differences with mean vertical displacement greater than lateral displacement in all three groups. The multiple pair comparison of mean values of lateral

displacement showed statistically significant between the groups ($p < 0.001$) (Table I). Similarly, the multiple pair comparison of mean values of vertical displacement showed statistically significant between the groups ($p < 0.001$) (Table II).

The conventional gingival retraction method showed more vertical displacement (0.21 ± 0.047 mm) than the lateral displacement (0.13 ± 0.044 mm), and the findings were statistically significant ($p < 0.05$). The magic foam gingival retraction method showed more vertical displacement (0.38 ± 0.053 mm) than the lateral displacement (0.22 ± 0.041 mm), and the findings were statistically significant ($p < 0.05$). The conventional gingival retraction method showed more vertical displacement (0.78 ± 0.082 mm) than the lateral displacement (0.61 ± 0.081 mm), and the findings were statistically significant ($p < 0.05$). Three study methods showed more vertical gingival displacement than that lateral gingival displacement. The comparison of lateral displacement and vertical displacement of three gingival retraction methods was summarised in Table III.

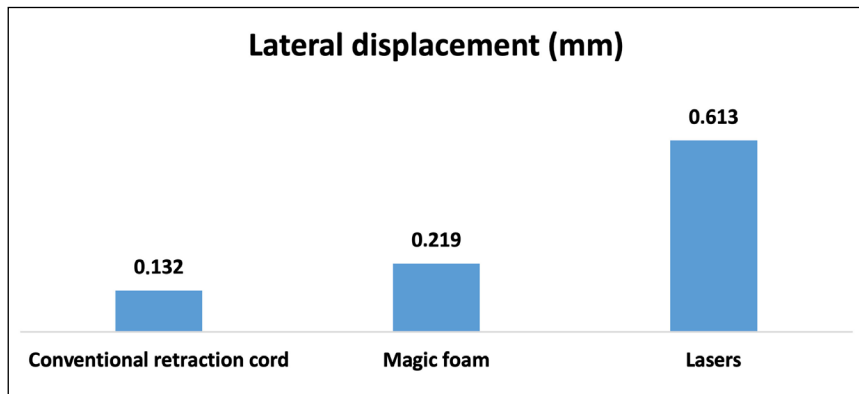


Figure 1. Intergroup comparison of values of lateral gingival displacement for the three groups.

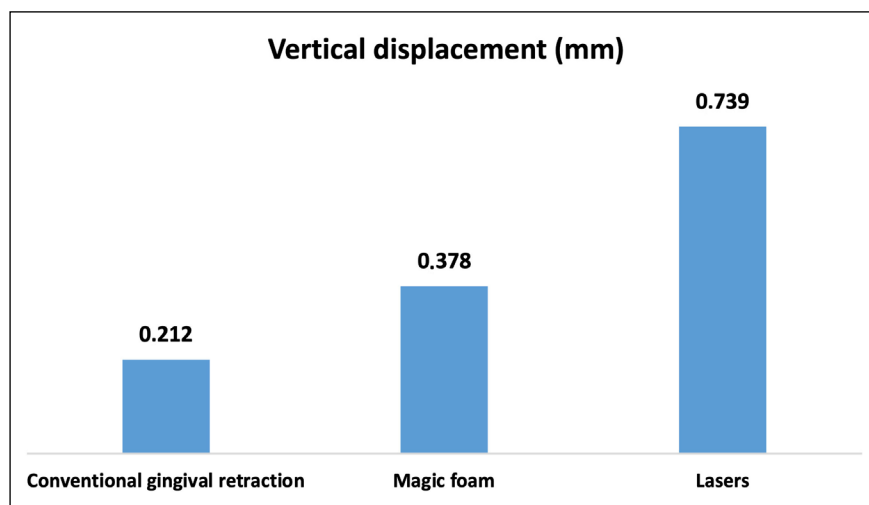


Figure 2. Intergroup comparison of values of vertical gingival displacement for the three groups.

Table I. Multiple pairwise comparisons for mean lateral displacement between three groups (conventional, magic foam, and lasers) using One-way ANOVA followed by post hoc Bonferroni test.

Pairwise comparison		Mean Difference (I-J)	Confidence Interval 95%		F value	p-value
			Lower Bound	Upper Bound		
Conventional retraction cord	Magic foam	-0.16650	-0.2156	-0.1174	366.451	<0.0001*
	Laser	-0.52700	-0.5761	-0.4779		
Magic Foam	Conventional retraction cord	0.16650	0.1174	0.2156		
	Laser	-0.36050	-0.4096	-0.3114		
Laser	Conventional retraction cord	0.52700	0.4779	0.5761		
	Magic Foam	0.36050	0.3114	0.4096		

*Significance $p < 0.05$ **Table II.** Multiple pairwise for mean vertical displacement between three groups using One-way ANOVA followed by post hoc Bonferroni test.

Pairwise comparison		Mean Difference (I-J)	Confidence Interval 95%		F value	p-value
			Lower Bound	Upper Bound		
Conventional retraction cord	Magic foam	-0.08700*	-0.1328	-0.0412	381.07	<0.001*
	Laser	-0.48100*	-0.5268	-0.4352		
Magic Foam	Conventional retraction cord	0.08700*	0.0412	0.1328		
	Laser	-0.39400*	-0.4398	-0.3482		
Laser	Conventional retraction cord	0.48100*	0.4352	0.5268		
	Magic Foam	0.39400*	0.3482	0.4398		

*Significance $p < 0.05$.**Table III.** Comparison of mean vertical and lateral displacement within individual groups using Independent *t*-test.

Retraction type	Displacement	N	Mean	Std. Deviation	Std. Error Mean	p-value
Conventional retraction cord	Lateral	20	0.13	0.044	0.001	0.00*
	Vertical	20	0.21	0.047	0.011	
Magic foam	Lateral	20	0.22	0.041	0.01	0.00*
	Vertical	20	0.38	0.053	0.012	
Lasers	Lateral	20	0.61	0.081	0.012	0.00*
	Vertical	20	0.78	0.082	0.018	

*Significance $p < 0.05$.

Discussion

For all impression procedures, gingival tissue must be displaced to allow sub-gingival finish lines to be registered. Numerous mechanical, chemo-mechanical, and electrosurgical methods are available for gingival retraction^{31,32}. Choosing an appropriate retraction method has now become an enigma to dentists. Biocompatibility of the mate-

rial, time taken, cost-effectiveness, and sufficient horizontal and vertical displacement are some essential criteria for selection³³. The present study evaluated three gingival retraction techniques retraction cord, magic foam, and lasers. The present study showed significant vertical and horizontal displacement of the gingival tissue by lasers, followed by magic foam, and retraction cords saw the least. Lasers have become a popular method

of choice in gingival procedures because of improved time and efficiency, lesser tissue shrinkage, bleeding, post-operative discomfort, and better healing^{31,32}. Dawani et al³⁴ compared lasers with magic foam and showed significant lateral displacement in the former, which is similar to the results of the present study. Gururaj et al³⁵ have shown contrasting results with lasers showing lesser gingival displacement than magic foam. The present study showed more significant horizontal and vertical displacement by magic foam compared to retraction cords. These findings are in contrast to some studies^{16,26} and both studies reported a non-significant difference in the displacement between the retraction cord compared to the magic foam cord.

As suggested by the manufacturer, Magic Foam Cord[®] (Coltene Waldent AG, Altstatten, Switzerland) is an expanding polyvinylsiloxane material designed for easy and fast retraction of the sulcus without the potentially traumatic and time-consuming packing of the retraction cords into the sulcus. Due to the counter pressure of the Comprecap Anatomic, there was an expansion of the Magic Foam Cord in the sulcus³⁶. It has many benefits, including easy handling, time-saving, painless to the patient, wide open sulcus without invasive techniques or materials; astringent is not required, no need to rinse, and more efficient when used on multiple teeth, unlike conventional retraction cords. The limitation of using magic form cords is that it is not cost-effective for all patients³⁷⁻⁴⁰. The conventional retraction cord showed the least gingival displacement; it is still the most commonly used method for gingival retraction during crown preparation. Still, it suffers from various drawbacks i.e. challenging to place, causes trauma to the tissue, and is very technique sensitive. With newer materials available in the market, it is essential to explore safer and less time-consuming options that provide adequate displacement. The present advocated the usage of lasers over other methods.

The present study advocates the use of gingival lasers over other retraction methods. Many studies⁴¹⁻⁴⁴, have compared the use of gingival lasers over other methods, but lasers have proved to be easier to use, less time-consuming, and more comfortable for patients. A Turkish⁴² study found that the retraction cord and cordless paste system procedures produced more excellent PD, GI, and BOP index scores compared to lasers, and the authors reported the findings with 12 months of follow-ups. Literature also suggests that laser

helps provide a sterile environment in the gingival sulcus⁴³. Another significant benefit of using lasers is a lesser gingival recession. It has been seen that lasers produce 2.2% gingival recession as compared to 10% done by the retraction cords. Lasers are very well accepted by all age groups, especially the pediatric population⁴⁴. The remarkable cutting ability and the tolerable damage zone clearly show that the diode laser is very effective because of its excellent coagulation ability in soft tissue use.

Conclusions

All of the retraction systems produced a highly significant amount of lateral and vertical displacement compared to their pre-displacement state.

The laser retraction system produced more amount of lateral displacement when compared to the magic foam and conventional retraction cord system.

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Ethics Approval

The institutional Review Board, Majmaah University, AlMajmaah, Saudi Arabia, approved the study under IRB No. MEU-Dec-27/COM-2020/16-3.

Informed Consent

Informed consent was obtained from all subjects involved in the study.

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Conflicts of Interest

The author declares no conflict of interest.

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Data Availability

Data will be available based on the request to the correspondence author.

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