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An in-vivo study to evaluate the clinical efficacy of different gingival retraction systems

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ABSTRACT

Background: Meticulous impression of the prepared teeth is of extreme importance for successful fixed prosthetic restorations. Gingival retraction allows access to finish lines and to create space for the impression material to record prepared and unprepared tooth structure. Dentists should carefully consider the various materials and methods of gingival retraction in light of the potential risks involved. **Aim:** The aim of this study was to assess and compare the amount of displacement in terms of lateral displacement by the Expasyl and Magic FoamCord retraction systems. **Materials and methods:** Study was conducted on the unprepared right and left maxillary central incisors for 10 subjects. Subjects were selected based on certain selection criteria. The pre-displacement and post-displacement impressions were made in a custom tray with monophasic addition silicone material using a single mix-one step impression technique. Final cast of maxillary central incisors was sectioned longitudinally into two equal halves. The sectioned halves were oriented on mounting jig using a spirit level and assessed under a traveling microscope. The measurements were made from the crest of the gingival margin to the mid-buccal surface of the tooth. The amount of gingival displacement in each group was calculated by subtracting the pre-displacement values from post-displacement values. From the observations obtained statistical analysis was performed using paired 't' and unpaired 't' test. **Results:** Group I produced more amount of lateral displacement than Group II. However, the amount of gingival displacement between Group I and Group II showed a statistically significant difference. **Conclusion:** Expasyl pastes retraction system showed more lateral displacement of gingiva compared to Magic Foam Cord system.

Keywords— Tissue displacement, Retraction, Marginal finish lines, Custom tray, Impression, Esthetics

1. INTRODUCTION

Today's epoch of increasing esthetic demands and improved patient's awareness has led fixed prosthodontics to play an indispensable role. The relationship between a fixed prosthesis and soft tissue should be considered pivotal for the long term success. Several studies suggest that supragingival margins are recommended; nevertheless, for esthetic demands, sensitivity, need for additional retention and existing sub-gingival caries and/or restorations, placement of intracrevicular margins are indicated¹.

Impression making for fixed prosthesis requires access to the finish lines while minimally traumatizing the tissue so that clinicians can provide requisite clinical information to the laboratory technician. In addition to creating a clean dry field free of fluid and debris, gingival tissue must be displaced for precise registration of prepared and unprepared tooth structure. This information allows the technician to design a prosthesis that achieves adequate marginal integrity and emergence profile and thereby allows harmony between the gingival tissue and restoration. Improper tissue management and faulty impression techniques can lead to irreversible damage to the soft tissue and unesthetic restoration later¹.

According to The Glossary of Prosthodontic Terms (GPT-8): "Gingival displacement is the deflection of marginal gingiva away from the tooth."² Gingival tissue must be displaced temporarily not only during impression making but can also be displaced during tooth preparation and cementation of the prosthesis.

Donovan TE et al., and Nemetz H et al., mentioned the various acceptable criteria for gingival deflection procedures as:

- It must provide sufficient lateral and vertical displacement of gingival tissues along with adequate hemostasis and should control seepage of sulcular fluid.
- It should be less time consuming.^{3,4}
- It should not cause irreversible tissue damage.^{3,4}

Clinical procedures for tissue displacement may include mechanical, mechanicochemical, electrosurgical, rotary, gingival curettage and laser surgery or combination of these. Most commonly used method which causes least gingival trauma is using cords with or without chemical agents. Mechanical displacement of the cord can be improved by impregnating it with various concentrations of different chemicals like epinephrine, ferric sulphate, aluminium chloride, aluminium sulphate, tannic acid and zinc chloride.⁵ However combinations of chemicals are advocated by some.⁶ Seldom any drug is completely free of side-effects that may vary from a mild inflammatory response to tachycardia, increased respiratory rate, nervousness and increase in pulse rate and blood pressure.^{3,7,8} Apart from conventional mechanicochemical methods, new techniques and materials have also been developed in search of better efficacy, lesser side effects and comfort of the patient. A new atraumatic gingival displacement method was introduced by Dr Lesage in 1999, by using Expasyl. It is a paste used for gingival displacement that physically displaces the tissue with either little or no pressure and leaves a dry field free of blood, ready for making an impression.^{9,10}

The technique being painless does not require the use of anaesthesia and cause no inconvenience to the dentist as well as to the patients. Magic FoamCord, yet another atraumatic gingival displacement method, was the first expanding polyvinyl siloxane retraction material. It can be used along with Comprecap Anatomic or soft putty to bring about adequate gingival displacement. It is easy, atraumatic and less time-consuming method for displacing the gingiva. There is no haemostatic chemical added to it which prevents contamination of the impression materials.¹¹

Various studies have been done so far on various retraction methods and on various chemicals. However, conclusive evidence with respect to a single method or material to attain this objective is inconspicuous. This absence, when coupled with the claims of supremacy made by recently introduced methods and materials, creates a conundrum in the mind of the clinicians. Moreover, there is no conclusive evidence regarding the efficacy of newer materials. Therefore, a need was felt to design a study, to evaluate and compare the amount of displacement in terms of lateral displacement by Expasyl paste system and Magic Foam-Cord system.

2. MATERIALS AND METHODS

The study was conducted on the unprepared right and left maxillary central incisors of 10 selected undergraduate dental students of Govt. Dental College and Hospital, Srinagar (6 males and 4 females). Unprepared teeth were selected as mechanical trauma during preparation per se may cause injury and inflammatory response of the gingiva and so comparative results regarding the efficacy of agents would not be realistic.^{12,13} Selection criteria for the subjects were as follows:

- Students of the age group of 19-24 years with a full complement of natural teeth (the third molar may/may not be present).
- No orthodontic treatment should have been done and without any malocclusion with special attention on crowding, rotation or diastema in anterior teeth.
- Good gingival health and without any systemic diseases were selected.

To obtain a baseline gingival health record, all subjects had undergone oral prophylaxis 10 days prior to the impression and clinically healthy gingiva was demonstrated by Gingival Index is given by Loe and Silness (1964).^{14,15}

Preliminary impressions were made and the casts were obtained. A double-thickness modeling wax sheet was adapted as a spacer on the maxillary anterior region of the dental cast. Tissue stops on the incisal edges of the lateral incisors on either side with four additional stops at the tissue areas were made to prevent the movement of the tray. An aluminium foil was adapted over the spacer and auto-polymerizing resin tray material was used to fabricate the custom tray (figure 1).

One custom tray for each volunteer was used to make an impression of the pre and post-displaced gingiva with the two different gingival retraction systems. The custom tray improved the accuracy of an elastomeric impression by limiting the shrinkage by the unequal thickness of the material.¹⁴ the accuracy of the impression made in autopolymerized resin tray is comparable to that of thermoplastic or light-polymerized resin. Two coats of tray adhesive were applied and dried for 10 minutes to avoid separation of impression material from the tray. The handle of the custom tray was numbered using straight fissure bur. Pre-displacement and post-displacement impressions were made with monophasic addition silicone impression material (Aquasil Ultra Monophasic, Dentsply De Trey, Germany) using a single mix-one step impression technique.^{16,17} Automixing dispensing gun was used to ensure homogeneous mixing of base and catalyst and reducing air incorporation during the mix. The material was initially bled before applying the automixing tip to ensure free and even flow of the base and catalyst. The maxillary anterior region was isolated using cotton rolls to ensure a clean dry surface, free of saliva. Addition silicone was then injected into the gingival crevice by the help of the intraoral tip. The material was also placed in the custom tray and gently seated in the mouth. Impressions were allowed to remain in place without movement until it sets. After 5 minutes as per the manufacturer's specification, the trays were retrieved. The impressions were inspected under magnification. Voids and streak free impressions with adequate extensions were included in the study. Upon removal, the impressions were rinsed under running tap water and disinfected by immersing it in 5.25% sodium hypochlorite solution for 10 minutes. An impression was made of the pre-displaced gingiva to measure the initial sulcus width.

Gingival retraction systems were divided into two groups as:

Group I- Expasyl paste system (figure 2)

Group II- Magic FoamCord retraction system (figure 3)

The two retraction systems were randomly tested on right and left central incisors of all the 10 volunteers to eliminate bias to the maximum possible extent. Then, after 14 days of the first session, the test groups were interchanged within subjects.

In the case of Group I that is Expasyl paste system, the maxillary anterior region was isolated with cotton rolls and air-dried using the 3-way syringe. The cartridge of Expasyl along with the tip was loaded in the dispenser. The piston was pushed so that paste is

slowly injected into the sulcus starting from the mesio-labial line angle to the disto-labial line angle of the tooth. A sufficient quantity of the paste was placed to completely fill the sulcus, which produced blanching of the marginal gingiva (figure 4). Expasyl was left in place for 2 minutes (as per manufacturers' recommendation) after which it was thoroughly washed out with a jet of water from the 3way syringe. Expasyl was completely removed before making a post-displacement impression.

In the case of Group II that is, Magic FoamCord retraction system, Comprecap anatomic technique was used as per manufacturer's instructions. The cartridge was attached to the dispenser and allowed to bleed initially till an equal amount of base and catalyst flowed out ensuring uniform mixture. The mixing and intra oral tips were placed on the cartridge and the isolation of the anterior region was carried out in a similar manner. Adjustment to the Comprecap Anatomic was done according to the tooth contour. The Magic FoamCord was injected into the sulcus starting from the mesio-labial line angle to the disto-labial line angle of the tooth. Constant pressure was applied on the Comprecap by the antagonist teeth of the subject (figure 5). It was left in place for 5 minutes, after which Comprecap Anatomic and Magic FoamCord material was removed. Post-displacement impressions were made immediately after the removal of the retraction system and evaluated in a similar manner as pre-displacement impressions (figure 6). Each of the groups was further divided into subgroups 'a' and 'b' representing pre-displacement and post-displacement impressions/final casts respectively. The impressions were poured with Type IV dental stone using vacuum mixer and vibrator. After the final set of Type IV stone, the casts were retrieved and trimmed to obtain a flat base. The mid line of maxillary central incisors on buccal and palatal surfaces of the casts was marked using digital calliper at the cervical and coronal level. They were sectioned by using a mechanical saw in an apico-coronal direction with the midline as a reference point. Thus, each tooth had two equal halves and was used for measurement. The sectioned halves were stabilized on mounting jig with the help of clay material and checked by spirit level (figure 7). Pre and post-displacement sulcus width were studied by placing the sectioned halves under a travelling microscope. The measurement was made from the crest of the gingival margin to the corresponding mid buccal surface of the tooth (figure 8). Thus the data of the width of the sulcus at the crest of the gingival margin were obtained for both the halves. The mean of these two values was considered as one reading. Pre and post-displacement sulcus width were measured for all the samples.

The amount of lateral displacement was calculated by subtracting the pre-displacement values from the post-displacement values of all the sectioned halves.

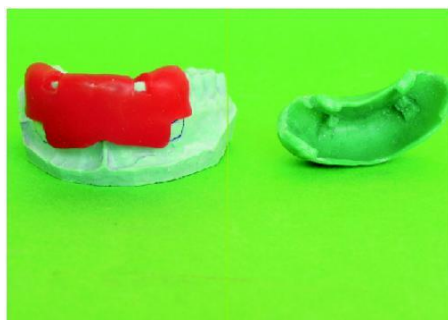


Fig. 1: Spacer design and custom tray



Fig. 2: Expasyl Retraction System



Fig. 3: Magic FoamCord Retraction System



Fig. 4: Displacement by Expasyl Paste Retraction System



Fig. 5: Displacement by Magic Foam Cord Retraction System

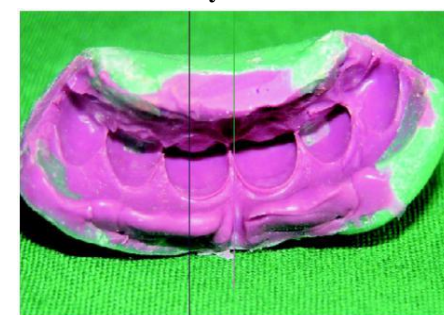


Fig. 6: Post displacement impression



Fig. 7: Cast mounted on the jig

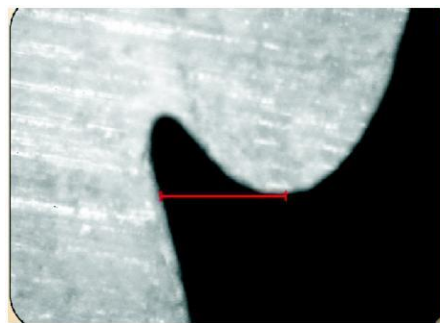


Fig. 8: Measurement from the crest of the gingiva to the tooth surface

3. RESULTS

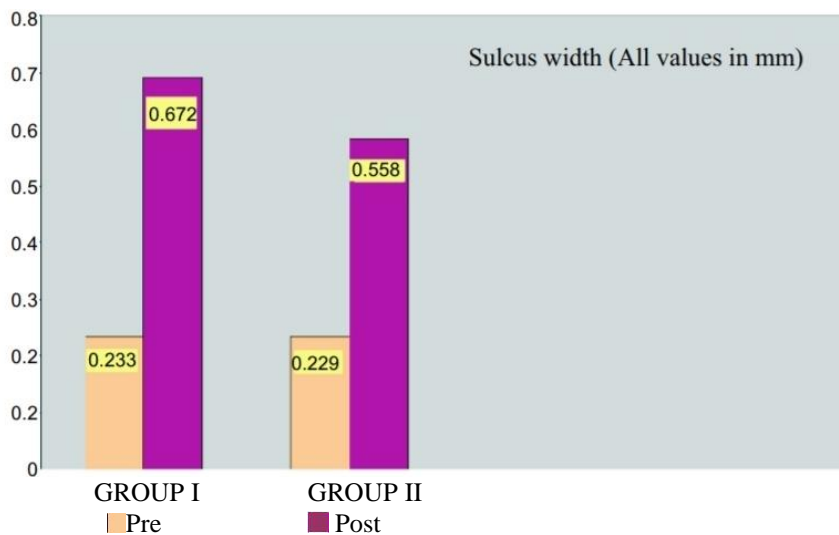


Fig. 9: Bar diagram

Comparison between pre and post-displacement values of gingival sulcus in the 2 groups

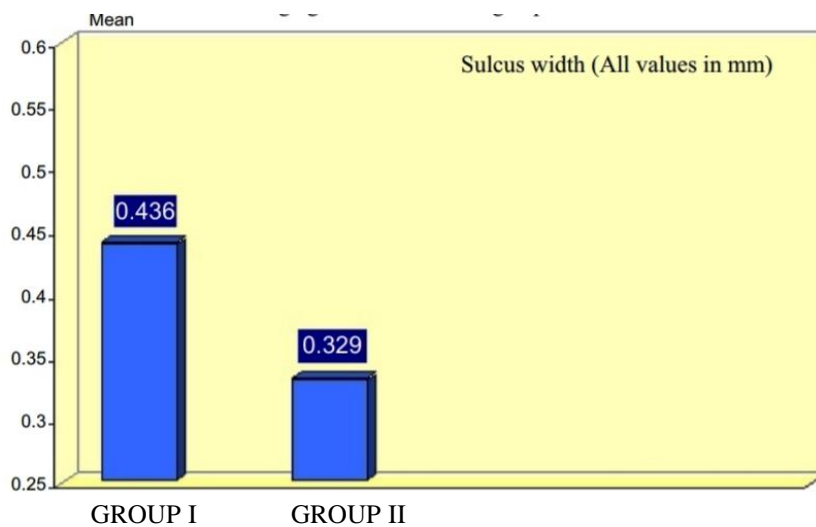


Fig. 10: Bar diagram

Comparison of the amount of displacement in the 2 groups:

Data for all the groups were obtained and statistical analysis was done by applying paired 't' and unpaired 't' test. The post-displacement values of both the groups were analyzed, and it was found that Group I produced more displacement (mean value 0.672mm) than Group II (mean value 0.558mm) (bar diagram 1).

The amount of lateral displacement in both groups was calculated by subtracting the pre-displacement values from the post-displacement values. The amount of lateral displacement of both the groups was analyzed, it was found that Group I (mean value 0.4360 ± 0.05461 mm) produced more displacement than Group II (mean value 0.3290 ± 0.03784 mm) (Bar diagram 2). Comparison between both the groups produced a highly significant amount of gingival displacement.

ANOVA test was applied to check the pre-displacement values amongst both the groups. Both the groups were comparable as there was no statistically significant difference (p-value >0.05).

Post-displacement sulcus width values were compared to their pre-displacement in each of the groups. They were analyzed by applying paired 't' test. It was clearly evident that both gingival retraction systems produced a highly significant amount of gingival displacement when compared to their pre-displacement state (p-value <0.001).

4. DISCUSSION

The clinical success of fixed prosthodontic restorations fabricated in the dental laboratory depends on the accuracy of the final impression. A good quality impression is influenced by the location of the finish lines, periodontal health and sulcus bleeding during impression making.^{18, 19} Modern impression materials employed in the restorative dentistry require displacement of gingival tissues to expose and record the intracrevicular and/or equigingival finish lines on the tooth surface. The gingiva must be displaced temporarily to make an accurate impression and can also be done during the completion of the preparation and cementation of the restoration.²⁰

Gingival displacement is simple and effective when dealing with healthy gingival tissues and margins that are properly placed slightly into the sulcus.^{5,21} Technical complexities have limited the use of surgical methods of gingival displacement such as rotary curettage, electro-surgery and lasers.²² Slow tissue recovery and the clinically significant gingival recession was reported with rotary curettage and electrosurgery.^{23,24} In contrast, cord induces least clinical damage to the periodontal tissues, both in terms of recession and attachment loss.²⁵ The mechanochemical method is easy and most commonly used and causes minimal trauma to the tissues.^{26,27} However, it has some disadvantages of causing trauma to the gingiva, side effects of chemical agents, technique sensitivity and is more time-consuming.

The search for an ideal gingival displacement method, exhibiting an adequate amount of deflection with minimal or no trauma to the gingival health and having no systemic side effects have been in progress for years. However, the dispute about the efficacy and reliability of chemical solutions still continues.²⁸ Nowadays, various atraumatic methods of gingival displacement are available and claim-ed to be superior and comfortable than the conventional methods. Clinical efficacy of these newer methods is yet to be proved over the time tested conventional methods.

Jokstad A and Raja Z et al., in their clinical study found the superiority of knitted cord over braided cord.^{5, 29} However, no conclusive evidence is there to state superiority of knitted cord over braided cord.⁶ Mechanical displacement of the cord can be improved by impregnating it with various concentrations of different chemicals like epinephrine, ferric sulphate, aluminium chloride, aluminium sulphate, tannic acid and zinc chloride.⁷ However combinations of chemicals are advocated by some.⁸

All materials cause injury to a certain extent which varies from slight to severe. Time for the gingival health to return to its normal state has been controversial. According to some authors it occurred within 24-72 hours, 7-10 days, 8 days, 14 days or 30 days.^{12, 20, 23, 24, 26, 27, 30-32} The time required by the gingiva to return to its healthy state depends on the varying duration of retraction time by the cord, concentration and action of the drug used, trauma during preparation and/or cord placement and the condition of the gingival tissue.

After healing, the gingiva would have returned to its original unaltered state. So to be on a safer side, in this study 14 days' time interval was kept between two successive sessions. Then after 14 days of the first session, the retraction systems were interchanged within volunteers.

Various researchers found that time for which the retraction cord should be placed differs. It is critical to wait for a certain time before removing the cord and making the impression because cord needs time to produce adequate lateral displacement and medicament needs time to create hemostasis and control crevicular fluid.⁸ Harrison in his histologic examination revealed that after 5 and 10 minutes of retraction periods, the tissue returned to normal in 7-10 days whereas 30 minutes of retraction, healed in 14 days.¹² Whereas Baharav H et al. concluded that no significant difference in crevicular width was found at any period of tissue displacement for 4, 6 and 8 minutes with impregnated cords.³³

The time for Group I i.e., Expasyl retraction system was kept 2 minutes as per the manufacturer's recommendation.¹² The time for Group II i.e. Magic FoamCord retraction system was kept 5 minutes as per the manufacturer's recommendation.¹¹

In Group I, Expasyl retraction system which contains kaolin, aluminium chloride and water, showed effective displacement. Aluminium chloride was used as an astringent because it causes hemostasis. They act by precipitating proteins in superficial cells, which get hardened. It does cause irritation or injury to the soft tissue and shows good tissue recovery.^{11,12} Its efficacy may also be related to the mechanical action of kaolin having viscous clay-like consistency causing a physical displacement that results in its mechanochemical action.³⁴ Expasyl is to be injected into the gingival sulcus with a specially designed syringe, which delivers controlled pressure of 0.1N/mm².³⁵ This pressure is far below to damage the epithelial attachment and at the same time sufficient enough to bring about adequate displacement.³⁶ Expasyl disadvantage is its water solubility, so it may lose its effectiveness in moist sulcular environment to displace the gingiva. Improper angulations of the dispensing tips and/or large dispensing tip may not allow adequate flow of the material into the sulcus.

In Group II, Magic FoamCord retraction system caused physical displacement of the gingiva due to expanding polyvinyl siloxane material along with Comprecap Anatomic. Gingival displacement could be due to expansion (160%) of the elastomeric material

in 5 minutes and gentle pressure exerted by the Comprecap Anatomic.³⁷ Elastomeric material is devoid of astringent, thereby claiming to be favourable for the tissues with no risk of contamination of the impression materials.²² It exerts gentle pressure over the gingival tissues thus making it an atraumatic method. Reason for the lesser efficacy among the groups could be directly related to its lack of ability to control the flow of crevicular exudates or inability of expanding Polyvinyl siloxane to displace the gingiva. Other reasons could be an improper adaptation of the Comprecap Anatomic to the tooth contours and lack of continuous pressure applied by the patient.

Criteria for assessment of the clinical performance of the cord could be done by direct intraoral measurement with a miniature video camera or by indirect assessment of the sulcus dilation with impression material. Indirect measurement of sulcus width was done by using traveling microscope and measuring microscope.³³ However, data on the precision and accuracy of these measurements were not reported.

Laufer BZ et al., through their study on the linear accuracy of the impressions and stone dies as affected by the thickness of impression margin stated that the smallest crevicular width enabling consistent accuracy and defect free impression was 0.22mm.³⁸ They also demonstrated difficulties in obtaining good impressions of abutments that have narrow sulcular widths which ranged from 0.08-0.18mm. They found that 50% to 90% of impressions of the abutments had defected with sulcular widths of 0.08-0.13 mm.³⁹ So impressions and dies made from abutments with wider sulci demonstrated accurate registration of the margin with least distortion.

So, both the retraction groups in the study produced a greater amount of gingival displacement than the minimum amount of sulcus width required for the elastomeric impression material. This clinically indicates that newer retraction systems could produce an adequate amount of gingival displacement to record the intracrevicular margin effectively. It will also guide the clinician to select a suitable retraction system to achieve adequate gingival displacement for proper registration of prepared and unprepared tooth structure required for the development of marginal integrity and emergence profile.

However, there were certain limitations of the study like:-

- (a) Results of this study need to be verified on a larger clinical size comprising of various age groups and with more retraction systems.
- (b) Results of the study are to be evaluated on a variety of clinical sites i.e. in anterior as well as posterior segments of both maxillary and mandibular arch.
- (c) Additional studies are also required to determine the effect of different sizes of cords, medicaments and different time intervals after removal of cord on the width of the sulcus.

6. CONCLUSION

Through the results of the study, the following conclusions were drawn:-

- (a) Both the gingival retraction systems used showed a highly significant amount of lateral displacement when compared to their pre-displacement state.
- (b) Expasyl paste retraction system showed more amount of lateral displacement of gingiva when compared to Magic Foam Cord system.

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