

# An Evaluation of the Efficacy of Different Gingival Retraction Materials on the Gingival Tissue Displacement (A Comparative *In Vivo* Study)

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## ABSTRACT

**Background:** An accurate adaptation of the crown to the finish line is essential to minimize cement dissolution and to preserve periodontium in fixed partial denture cases. An accurate adaptation of crown is possible only when preparation details are captured adequately in the impression and transferred to cast. For these reasons, gingival displacement is necessary to capture subgingival preparation details. The aim of the present study is to measure *in vivo* the horizontal displacement of the gingival sulcus obtained by using three new cordless retraction materials (Magic Foam Cord®, Racegel and Astringent Retraction Paste) in comparison to medicated retraction cord.

**Materials and method:** Thirty-two patients requiring porcelain fused to metal fixed partial denture for replacement of a missing maxillary posterior tooth (either one of the premolars or the first molar). The patients are randomly divided into four groups of eight patients each according to the type of gingival retraction material used as follows: Group I: Medicated retraction cord (racemic epinephrine hydrochloride  $0.3 \pm 0.2$  mg per inch of cord, #00), Group II: Magic Foam Cord® (expanding polyvinyl siloxane), Group III: Racegel (25% aluminum chloride gel) and Group IV: Astringent Retraction Paste (15% aluminum chloride paste). Three depth orientation grooves were prepared in the buccal and palatal surfaces of a maxillary premolar parallel with the long axis of the tooth, extending from the middle third to the gingival third with the level of the free gingiva using a flat-ended diamond fissure bur. Impression of the gingival sulcus was then made using monophasic polyether impression material (Impregum™ Penta™ Soft, 3M ESPE, Germany), before and after gingival retraction with either of the aforementioned gingival retraction materials. The sulcus width, before and after gingival retraction was measured on the master cast (in  $\mu\text{m}$ ), after its sectioning longitudinally bucco-palatally at the middle of the prepared grooves using a rotary diamond disc. The measurement carried out by using digital microscope (Dino-Lite) at a magnification of 230X. The horizontal gingival displacement (the distance from the end of each prepared groove to the crest of the gingiva) measured by subtracting the gingival sulcus width after retraction from that before retraction.

**Results:** The findings of the present study showed that the highest mean of horizontal gingival displacement is recorded by Group IV (Astringent Retraction Paste) (250.7900  $\mu\text{m}$ ), whereas the lowest mean of horizontal gingival displacement is recorded by Group III (Racegel) (78.0988  $\mu\text{m}$ ). One-way ANOVA test showed statistically highly significant differences among groups ( $p < 0.01$ ). Least Significant Difference test (LSD test) was also used to make multiple comparisons among groups and revealed a statistically highly significant difference between each two groups ( $p < 0.01$ ).

**Conclusion:** The two new gingival retraction pastes (Astringent Retraction Paste and Magic Foam Cord®) could be used for gingival retraction as alternatives to medicated retraction cord. They offer advantages of simplified placement technique and shorter application time with greater gingival retraction. Meanwhile, the use of Racegel alone is not recommended for gingival retraction since it provides the least gingival displacement.

**Key words:** Gingival tissue, retraction paste, medicated retraction cord. (J Bagh Coll Dentistry 2015; 27(4):25-31).

## INTRODUCTION

The relationships between a fixed partial denture and the surrounding hard and soft tissue should be considered crucial for long-term success. A fixed partial denture requires an accurate impression that records the location of the finish line of the prepared tooth and a portion of the apical uncut tooth structure. This is important so that the restoration has a suitable emergence profile with well-adapted and smooth gingival margins. An accurate adaptation of the crown to the finish line is essential to minimize cement dissolution and to preserve periodontium in fixed partial denture cases.

An accurate adaptation of crown is possible only when preparation details are captured adequately in the impression and transferred to the cast. For these reasons, gingival displacement is necessary to capture subgingival preparation details.<sup>(1)</sup>

Elastomeric impression materials are popular due to their high degree of accuracy in registering details. However, most of these materials have an inherent lack of wettability that may prevent adequate registration of soft and hard tissue details. Therefore, the control of fluids in the gingival sulcus is mandatory, particularly when hydrophobic impression materials are used, as the sulcular fluid can lead to a deficient impression of the crucial finish line.<sup>(2)</sup>

There are different techniques for gingival displacement, including: mechanical retraction, chemo-mechanical retraction, displacement pastes

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and surgical retraction techniques.<sup>(3)</sup> The mechanical method of gingival displacement using retraction cord has been a standard for several years. It acts by physically pushing the gingival margin away from the finish line, but its effectiveness is limited because of its inability to control the sulcular fluid seepage. The chemo-mechanical method using cords impregnated in hemostatic agents is the most commonly advocated. It acts by physically pushing the gingival margin away from the finish line and its ability to control the sulcular fluid infiltration from the walls of the gingival sulcus. However, the placement of the cords into the gingival sulcus may cause slight trauma to the sulcular epithelium and is also time consuming.<sup>(2)</sup>

In an attempt to be a convenient, fast and effective needed for gingival retraction materials, several retraction paste systems have entered the dental marketplace. Providing a proper and simplified placement technique, these products are easy to use and can be gentler than cord to the gingival tissues. All currently available paste systems have a very similar placement protocol.<sup>(4)</sup>

Most of these materials contain aluminum chloride in different concentrations for hemostasis and claimed to provide blood-free retraction, making capturing an accurate impression easy, simple and predictable. Each system uses a slightly different delivery system, has different consistencies and may include specially designed accoutrements to aid in getting the material into the sulcus and keeping the tissue dry.<sup>(4)</sup>

Magic Foam Cord<sup>®</sup> gingival retraction system is one of these new cordless paste gingival retraction systems introduced by Coltène/Whaledent. Magic Foam Cord<sup>®</sup> is the first expanding vinyl polysiloxane material, which displaces the gingival tissue without being potentially traumatic and less time-consuming when compared with retraction cord.<sup>(5)</sup>

Racegel is another one of these cordless paste gingival retraction systems introduced by Septodont. It is a flavored gel-like product containing 25% aluminum chloride and exhibits thermo-viscosifying properties.<sup>(4)</sup>

Recently, 3M ESPE has introduced their Astringent Retraction Paste, containing 15% aluminum chloride, which offers several improvements over other delivery systems. The material is dispensed in hygienic unit dose capsules. Its placement tip is finer than those of the other systems and has a soft edge tip giving easy access to the gingival sulcus, especially in interproximal regions.<sup>(4)</sup> However, there is no available study in the literature coping with the

tissue displacing efficacy of these new retraction pastes; therefore, the present study is conducted.

## MATERIALS AND METHODS

### Patient Selection:

Thirty-two patients ages between 25-55 years requiring porcelain fused to metal fixed partial denture for replacement of a missing maxillary posterior tooth (either one of the premolars or the first molar) recruited from those patients attending the Postgraduate Clinic of the Department of Conservative Dentistry, College of Dentistry, University of Baghdad are selected. All patients had good oral hygiene, free of gingival inflammation, normal gingival sulcus depth of 2mm<sup>(6)</sup> and with well-aligned abutment teeth were with no rotation, drifting or crowding.<sup>(7)</sup>

It is worth to mention that all the clinical and laboratory steps, starting from the pre-operative impression to the sectioning and even the microscopical examination were performed by the same operator (i.e., the researcher herself).<sup>(7,8)</sup>

### Pre-Operative Impression:

A pre-operative impression was taken for each patient using chromatic alginate hydrocolloid impression material (fast setting) (tropicalgin, Zhermack, Italy) and disposable rim lock plastic impression tray (position<sup>™</sup> tray, 3M ESPE, Germany). The pre-operative impression was poured immediately<sup>(9)</sup> with the type I gypsum product (plaster of Paris) to obtain a diagnostic cast which was used to construct a special tray.

### Fabrication of Custom Tray (Special Tray):

For each patient, two special trays were fabricated to take two final impressions: one before gingival retraction and the another after gingival retraction. A special tray (half arch) was constructed on the diagnostic cast to act as a carrier for the impression material.<sup>(2)</sup> The special tray was extended from the central incisor to the last molar on the working side and provided a 2mm space for the impression material with stoppers. It was constructed by using photopolymerized acrylic resin.

### Sample Grouping:

The thirty-two patients were randomly divided into four groups of eight patients each according to the type of gingival retraction material that would be used as follows:

**Group I:** Medicated Retraction Cord (UltraPak<sup>®</sup> ETM, Ultradent products, Inc., USA).

**Group II:** Magic Foam Cord<sup>®</sup> (Coltène/Whaledent AG, Switzerland).

**Group III:** Racegel (Septodont, France).

**Group IV:** Astringent Retraction Paste(3M ESPE, Germany).

#### Reference Groove Preparation:

Three depth orientation grooves were then prepared in the pre-drawn lines parallel to the long axis of the tooth extending from the middle to the gingival third at the level of the free gingiva using a flat-ended diamond fissure bur No. (6847KR) (Komet, Germany) followed by a bur No. (8847KR) (Komet, Germany) for finishing in a high speed air turbine hand-piece with water coolant.

The width and depth of each groove were 1mm which corresponding to the diameter of the burs used for preparation and finishing. These grooves would serve as a reference for measurement of the horizontal displacement of the gingival tissue.

#### Final Impression:

After the preparation of the depth orientation grooves, two final impressions were taken for each patient using monophasic polyether impression material (medium consistency) (Impregum™ Penta™ Soft, 3M ESPE, Germany) and the previously constructed special tray: the first one without doing gingival retraction, which would serve as a control to give a baseline measurement of the sulcus width.<sup>(8)</sup>

The second final impression was taken after doing gingival retraction with either of the aforementioned gingival retraction materials and then poured with type IV die stone to measure the horizontal displacement of the gingival tissue on the stone cast after its sectioning.<sup>(6,10)</sup>

#### Gingival Retraction Procedure:

##### Group I (Medicated Retraction Cord Group)

In group I, the gingiva was retracted with Medicated Retraction Cord (Ultrapak® ETM, Ultradent products, Inc., USA) following the manufacturer's instructions. It was placed in the sulcus from mesio-palatal to the mesio-buccal by using a cord packer with serrated circular heads, then left in place for 10minutes, then removed gently with a dental tweezer and the gingival sulcus was gently dried with an air syringe according to the manufacturer's instructions; the final impression was then taken.

##### Group II (Magic Foam Cord® Group)

In group II, the gingiva was retracted with Magic Foam Cord® (Polyvinylsiloxane, addition type silicone elastomer) (Coltène/Whaledent AG, Switzerland) following the manufacturer's instructions. Magic Foam Cord®, in a sufficient

amount, was then slowly injected into the sulcus from mesio-buccal to the mesio-palatal with the tip parallel to the long axis of the tooth and then the Comprecap Anatomic was placed above it and the patient was asked to bite on the Comprecap Anatomic.<sup>(7,8)</sup>

The Comprecap Anatomic was comfortably held in place under biting pressure for 5minutes. Both the Magic Foam Cord® and Comprecap were then removed in one piece<sup>(7)</sup> and the sulcus was washed with an air/water spray to remove any residue of retraction material according to the manufacturer's instructions and final impression was then taken.

##### Group III (Racegel Group):

In group III, the gingiva was retracted with Racegel retraction material (Septodont, France) following the manufacturer's instructions. Racegel was applied directly into the sulcus carefully, following the contour of the prepared tooth from mesio-buccal to the mesio-palatal with the tip parallel to the long axis of the tooth.<sup>(7)</sup>

It was kept in place for 2minutes; the gel was then completely removed with an air-water spray and gently dried with an air syringe according to the manufacturer's instructions, the final impression was then taken.

##### Group IV (Astringent Retraction Paste Group):

In group IV, the gingiva was retracted with the Astringent Retraction Paste (3M ESPE, Germany) following the manufacturer's instructions. The retraction paste was then slowly injected into the sulcus from mesio-buccal to the mesio-palatal with the tip parallel to the long axis of the tooth.<sup>(7)</sup>

After being in place for 2minutes, the retraction paste was completely removed from the sulcus by washing with an air-water spray and gently dried with an air syringe according to the manufacturer's instructions and final impression was then taken and poured with type IV die stone to obtain the master cast.

#### Sectioning and Microscopical Examination:

The master cast was fixed to the base of the modified dental surveyor with the fixing bar touched the edentulous area of the master cast for stabilization of the master cast during sectioning; the position of the base of the modified dental surveyor was then adjusted in such a way that a rotary diamond disc (0.27mm in thickness, 4.5 cm in diameter) was parallel to the drawn lines. The tooth was then sectioned longitudinally bucco-palatally following these lines, using a rotary diamond disc with a straight hand-piece

(Belmont) mounted in a modified dental surveyor (Bego).<sup>(6)</sup>

After sectioning, the sectioned specimen was painted with a blue pencil to give better contrast to distinguish the edge of the reference groove and crest of the gingiva during microscopical examination, followed by linear measurement of the horizontal width of the gingival sulcus from the end of each prepared groove to the crest of the gingiva, under a digital microscope (Dino-Lite) at a magnification of 230X, which was connected to the computer to capture the image. The flexible arm of the digital microscope was adjusted in such a way that the digital microscope was perpendicular on the sectioned specimens with 1.5cm distance when capturing the images. Image analysis software (Image J) was used to measure the width of the gingival sulcus at these three lines buccally and palatally, which was calculated in Pixels.<sup>(11, 12)</sup>

The image analysis measurements in pixels were calibrated using the image of a (1mm) increment taken at the same focal length and input into (Image J) by the option of set scale<sup>(13)</sup> that converted all calculated reading into (µm), followed by quantitative measurement of the horizontal distance (in µm) from the end of the prepared groove to the crest of the gingiva, before and after retraction of the gingival tissue.

The difference of sulcus width (before and after retraction for buccal and palatal grooves) was measured for each patient, then the mean for

each group was taken and used for comparison of significance among the groups.

## RESULTS

### Descriptive Statistics:

The descriptive statistics, which included the mean, standard deviation, minimum and maximum values, which were calculated for the four groups as shown in (Table 1) and (Figure 1).

The highest mean value of horizontal gingival displacement recorded in the present study was in Group IV (Astringent Retraction Paste) at around (250.7900 µm), whereas Group III (Racegel) showed the lowest mean value of horizontal gingival displacement which was around (78.0988 µm).

### Inferential Statistics:

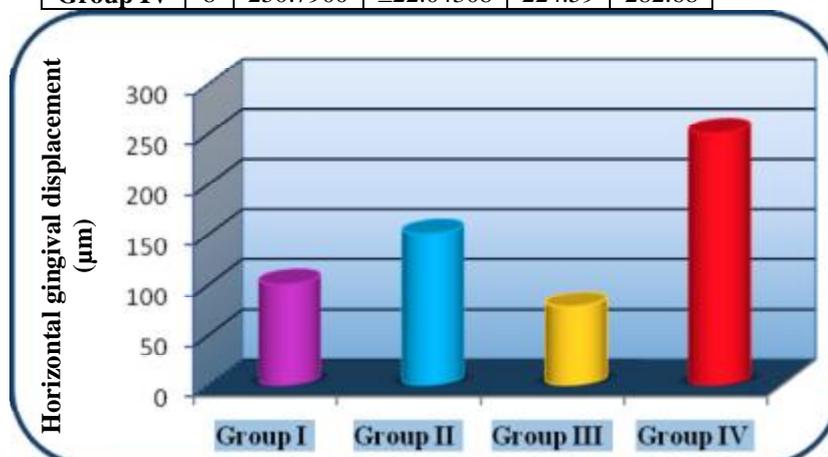
Comparison of significance among the different groups was done by using one-way ANOVA test at a level of significance of (0.05). ANOVA test revealed a statistically highly significant difference among groups ( $p < 0.01$ ) as reported in (Table 2).

Further, comparisons among groups were done using the Least Significant Difference test (LSD test) to see where the significant difference occurred as reported in (Table 3).

LSD test results showed that there were statistically highly significant differences in gingival retraction between all groups (Group I, Group II, Group III and Group IV) when compared with each other ( $p < 0.01$ ).

**Table (1): Descriptive Statistics of Horizontal Gingival Displacement for the Different Groups Measured in Micrometer.**

Groups	N	Mean	SD	Min	Max
Group I	8	100.6296	±14.23008	79.50	119.16
Group II	8	150.6097	±15.72547	126.60	171.04
Group III	8	78.0988	±9.29107	67.36	95.73
Group IV	8	250.7900	±22.04308	224.59	282.68



**Figure 1: Bar-Chart Graph Showing the Mean Values of the Horizontal Gingival Displacement in (µm) of the Four Groups.**

**Table 2: ANOVA Test for Comparison of Significance Among the Four Groups.**

	Sum of Squares	df	Mean Square	F	Sig.
<b>Between groups</b>	141339.974	3	47113.325	184.395	0.000 (HS)
<b>Within groups</b>	7154.047	28	255.502		
<b>Total</b>	148494.021	31			

**Table 3: LSD Test for Comparison of Significance between Each Two Groups.**

Groups		Mean Difference	S.E.	Sig.
<b>Group I</b>	<b>Group II</b>	-49.98013	7.99221	0.000 (HS)
	<b>Group III</b>	22.53088	7.99221	0.009 (HS)
	<b>Group IV</b>	-150.16038	7.99221	0.000 (HS)
<b>Group II</b>	<b>Group III</b>	72.51100	7.99221	0.000 (HS)
	<b>Group IV</b>	-100.18025	7.99221	0.000 (HS)
<b>Group III</b>	<b>Group IV</b>	-172.69125	7.99221	0.000 (HS)

## DISCUSSION

The objective of the present project is to study *in vivo* the tissue displacing efficacy of three new different gingival retraction pastes in comparison to the medicated retraction cord, which has long been used and considered as a standard technique to obtain gingival retraction. All the tested materials (Medicated retraction cord, Magic Foam Cord<sup>®</sup>, Racegel and Astringent Retraction Paste) share the property of being placed in the gingival sulcus of the prepared tooth, but they differ in their chemical composition, mode of action and time of placement.

The main advantage of using a cord in the current study is affordable and it could achieve varying degrees of retraction depending on its size. Thus, medicated retraction cord is considered as a standard. However, improper handling of cords might lead to gingival recession and marginal exposure of the prosthesis, which may negatively affect esthetics. Moreover, it has been reported by different researchers that the retraction procedure is inconvenient, time-consuming and uncomfortable for the patient.<sup>(14)</sup>

On the other hand, from a clinical point of view, all gingival retraction pastes are easier to place and require shorter application time when compared with the retraction cord. In addition, from a periodontal point of view, retraction pastes had been found to be better than cords when assessed histologically as reported by Phatale et.al.<sup>(7)</sup>; they respect the periodontium.

The methodology used in the present study for assessing the tissue displacing efficacy of the gingival retraction materials by taking two impressions (pre/post-retraction) has been reported by different researchers. However, the only difference among these studies is that some researchers assessed the tissue displacing efficacy

directly on the impression after its sectioning,<sup>(2, 8)</sup> while others assessed it on the cast obtained from the pre/post-retraction impressions after its sectioning.<sup>(6, 10)</sup>

In the present study, the tissue displaying efficacy of the tested materials was assessed on the sectioned stone casts rather than on the impression itself since distortion and tearing of the impression might occur during sectioning.

### Comparisons Among Groups:

In present study, the statistically highly significant differences in the horizontal displacement of the gingival tissues produced by the different materials could be attributed to the differences in the chemical composition, mode of action, consistency and application time of these materials.

The least gingival displacement shown by Racegel (Group III) which was statistically highly significant when compared with all other groups could be attributed to the low consistency of the material as it is a gel form and its short application time (2 minutes). This means that the material might act by chemical means only depending on the 25% aluminum chloride in its formulation, which was eased into the intra-crevicular space beneath the gingival margin owing to its gel consistency and fine application tip, shrinking the gingival tissues rather than mechanically pushing the sulcus away due to its low consistency. Moreover, the short application time recommended by the manufacturer might not give enough time for adequate retraction but only for hemostasis.

On the other hand, the greater gingival displacement shown by the medicated retraction cord (Group I) than Racegel could be due to the difference in the technique of gingival retraction (chemo-mechanical method) and longer application time (10 minutes). This means that the

material might act mechanically, pushing the sulcus away and stretched the circumferential periodontal fibers and by chemical means depending on epinephrine, which provided prolonged gingival vasoconstriction.<sup>(15)</sup> Moreover, the long application time recommended by the manufacturer might give enough time for retraction and hemostasis.

However, the horizontal displacement produced by the medicated retraction cord was less than that produced by Magic Foam Cord<sup>®</sup> (Group II) and Astringent Retraction Paste (Group IV) with statistically highly significant differences. This could be attributed to that Magic Foam Cord<sup>®</sup> contains expanding type polyvinyl siloxane material which generated hydrogen gas during setting and induced expansion. This means that the material might act by mechanical means depending on expanding type polyvinyl siloxane material that mechanically pushing the sulcus away due to its higher consistency and this was aided by the pressure exerted by the Comprecap. Moreover, the longer application time recommended by the manufacturer (5 minutes versus 2 minutes for Racegel) might give enough time for adequate retraction.

The greatest gingival displacement produced by Astringent Retraction Paste (Group IV) which was statistically highly significant when compared with all other groups could be attributed to its thicker consistency than Racegel and Magic Foam Cord<sup>®</sup> owing to its kaolin content and its fine application tip (1mm in diameter) which might allow the material to be inserted deeper in the sulcus. In addition to the thicker consistency, Astringent Retraction Paste contains polydimethylsiloxane and 15% aluminum chloride in paste form.<sup>(16)</sup> This means that the material might act mechanically pushing the sulcus away due to the high consistency of the kaolin material (an aluminum-silicate-hydrate), which absorbs GCF and expands, similar to Expasyl<sup>®(17)</sup> and by chemical means depending on aluminum chloride (15%) that was eased into the intra-crevicular space beneath the gingival margin by the fine application tip (1mm) and constricted the gingival tissues.

The results of the present study agree with the results of Prasanna et.al.,<sup>(2)</sup> who concluded that the mean width of the retraction paste (Expasyl<sup>®</sup>) was greater than the mean width of the retraction cord. Such agreement could be due to the similarity in size and type of the cord used (#00 knitted cord).

On the other hand, the results of this study disagree with the results of Kazemi et.al., and Gupta et.al.,<sup>(6,8)</sup> who concluded that the mean

width of the retraction cord was significantly greater than the mean width of the retraction paste (Expasyl<sup>®</sup>). Such disagreement could be due to the larger size of the cord used (#1), which might give better mechanical retraction than the thinner cord (#00) used in the present study. Another possible cause is the difference in the type of medicament used to impregnate the cord (15% aluminum chloride) used by Kazemiet et.al.,<sup>(6)</sup> and the difference in the composition of the cord used (softly braided retraction cord and ultra-fine copper filaments) used by Gupta et.al.,<sup>(8)</sup> which might give better mechanical retraction than the knitted cord used in the present study. Moreover, the finer applicator tip of Astringent Retraction paste used in the present study as compared with Expasyl used by Kazemi et.al., and Gupta et.al.,<sup>(6, 8)</sup> might allow the material to be inserted deeper than Expasyl.

We recommend the use of Astringent Retraction paste and Magic Foam Cord<sup>®</sup> since they provided better horizontal displacement of the gingival sulcus than medicated cords with the added advantages of simplified placement technique clinically shorter application time and Astringent Retraction paste provides better infection control because of its disposable hygienic unit dose capsules. On the other hand, we didn't recommend the use of Racegel alone for gingival retraction but only for hemostasis since it provides the least horizontal displacement of the gingival sulcus than other tested materials and its use might be necessary to be accompanied with retraction cords.

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