Comparison of gingival retraction produced by retraction cord and expasyl retraction systems - An in vivo study

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ABSTRACT

Statement of Problem: A gingival retraction system may be soft tissue friendly or could be easy to use or could be the tried and tested one. However, when compared to the results they produce, the clinical application is questioned. Aim: The aim of this study is to evaluate the amount of gingival retraction produced by expasyl retraction paste and plain retraction cord. Methods and Materials: This study included 39 subjects. After abutment, teeth were prepared for fixed partial denture, plain retraction cord or expasyl retraction paste was placed into the sulcus of the prepared teeth, and time taken for application was recorded and bleeding was noted after removal of retraction material. Gingival sulcus width was measured by travelling microscope. The gingival recession was measured using digital caliper. Results: The mean gingival width of retracted sulcus in both the groups showed no statistically significant difference between the two ($P < 0.05$). The mean time taken for application and hemorrhage of expasyl paste (99.34 min, 5.1% bleeding) was significantly less than plain retraction cord (221.89 min, 74.4% bleeding). In both phases, the gingival index and gingival recession in the cord group were significantly higher than expasyl paste group. Conclusion: From the study results, amount of gingival retraction with the use of expasyl retraction paste is almost similar in comparison to plain retraction cord; expasyl retraction system appears to produce less hemorrhage and needs less clinical time for application. The effect of retraction system on soft tissue health (plaque index, bleeding on probing, and mean gingival recession) in the expasyl paste group was significantly better than cord group. Clinical Significance: Retraction with expasyl paste producing similar amount of lateral displacement of the gingival margin, therefore based on the beneficial effects, it may be recommended for absorption of intraoral fluids and exerting moderate pressure on gingival tissue.

KEY WORDS: Cord, Expasyl, Gingival retraction, Gingival sulcus, Tissue displacement

INTRODUCTION

Fixed prosthodontic restorations and its success are largely dependent on the long-term health and stability of the surrounding periodontal structures.[1] Gingival margins exposure during tooth preparation before impression making is one of the most technique-sensitive procedures for the dentist to perform. This is further influenced by sulcular depth variation, distendability of gingival tissues, gingival inflammation, level of margin placement, and tissue laceration.[2] Clinically various methods are available for adequate gingival retraction, including mechanical retraction, mechanico-chemical retraction, electrosurgery, and rotary gingival curettage.[3,4] Therefore, various gingival retraction systems are available in the market, and a cordless retraction paste system (expasyl) is fairly new entrant into this field. This system promises to provide good retraction and excellent hemorrhage control. Furthermore, very few studies were done to compare this retraction system with commonly used retraction cords. Therefore, the present study is designed with the purpose to evaluate the amount of gingival retraction produced by “expasyl retraction system” and “plain retraction cord” and to compare them against their ease of use, hemorrhage control, and its effects on soft tissue health.

MATERIALS AND METHODS

The protocol of this study was revised and approved by the Department of Prosthodontics, Crown and Bridge, and Implantology, Saveetha Dental College and Hospital, Saveetha University, Chennai, India. Written informed consent was obtained from those who agreed to participate voluntarily before clinical trial, and ethical clearance was obtained from the

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Selection of Subjects

Subjects of age 18–50 years with 78 teeth (26 premolars, 23 molars, 18 incisors, and 11 canines) in both maxillary and mandibular arches, irrespective of sex, were selected by double-blinded block randomization method. Block randomization of two was employed (using simple lottery method) to allocate the treatment materials, Group I - expasyl retraction system and Group II - conventional retraction cord. All the subjects had no significant medical problems. All the subjects had no significant medical problems or any History of smoking, alcohol abuse or use of specific drugs. They were screened for periodontal health on their first visit according to criteria of the

1. Silness and Loe plaque index (“0” absence of plaque accumulation).
2. Loe and Silness gingival index.
3. Gingival sulcus depth between 1 and 2 mm.
5. No bleeding on probing.
6. Absence of deep periodontal pockets (pocket depth <3 mm).

All patients have been educated on how to maintain good oral hygiene.

Inclusion Criteria

Subjects with the following criteria were included in the study:

1. 20–50 years of age.
2. Full coverage restoration (tooth preparation involving more than one abutment teeth (at least two retainers).
3. Gingival and periodontal health of the abutment teeth to be sound.
4. Normal size and contour of abutment teeth (No developmental anomaly or regressive changes).

Exclusion Criteria

Subjects with the following criteria were excluded from the study:

1. Signs of periodontal disease.
2. Grossly decayed abutments.
3. Tipped, tilted or rotated abutments.
4. Medically compromised patients (diabetes, CVS disorders, hyperthyroidism, and hypertension) and pregnant women.

Statistical Analysis

Various statistical methods used in this study are as follows: (1) Independent t-test: To compare the mean values between groups and (2) Chi-square test: To compare two proportions, level of significance @ 5% (0.05) and power @ 90%.

Preparation of Subjects

A preliminary impression was made using irreversible hydrocolloid impression material (Tulip Alginate Impression Material, Cavex, Holland Bv, Haarlem Holland) and the impression was poured in orthokal-orthodontic stone Class III extra hard (Kalabhai Karson Pvt Ltd., Mumbai, India) for study casts. Two retraction materials, namely, Plain Retraction Cord (Ultrapak 1, Ultradent products, South Jordan, Utah, USA) and an injection type retraction paste with 15% aluminum chloride “expasyl retraction paste” (Expasyl, Satelec, Pierre Rolland, France) were used in this study after the preparation of abutment teeth for gingival retraction. Each subject received both types of retraction materials (using block randomization-simple lottery method) on the prepared abutments on all four surfaces (Buccal, mesial, distal, and lingual/palatal). In total, 78 teeth were prepared of which 39 teeth received retraction cord and other 39 teeth received expasyl retraction paste.

Preparation of Tooth

Tooth preparation with shoulder finish line was performed at the height of free gingival margin (equigingival) to prevent risk of violating biological width.[5] All abutments were prepared for full coverage metal ceramic restoration under local anesthesia (Lox 2% Adrenaline 1:200000, Neon Laboratories Limited, Andheri, Mumbai, India).

Preparation of Conventional Retraction Cord Method

Plain Retraction cord (Ultrapak 1, Ultradent Products, South Jordan, Utah, USA) of adequate size was selected based on the clinical situation (thickness of the gingiva and depth of the sulcus). Cord was soaked in saline solution for 20 min to enhance the mechanical effect. Cord of was cut and looped around the tooth, and packing was started from the mesial interproximal area by gently pushing the cord into the sulcus. The operator assessed the time taken for placement (from start of packing till completion) of cord and was recorded (in seconds). The cord was left in the sulcus for 5 min, after which it was slowly retrieved and bleeding was recorded (in terms of yes or no).

Preparation of Expasyl Retraction Method

Expasyl retraction paste ensures reflection of the marginal gingiva and drying of the sulcus. The material
Expasyl paste is supplied in capsules (cartridges) of expasyl paste, applicators, and comes with a gun type of device into which capsule has to be placed and then material is expressed. The paste was then loaded into the sulcus slowly resting on the tooth with tip parallel to long axis of teeth. No pressure was applied on gingiva with the cannula. Sufficient quantity of retraction paste could be discerned by a slight blanching of marginal gingival area. It was kept in sulcus for 2 min. It was easily visible because of its color. The operator assessed the time taken for placement (from start of loading till completion) of expasyl paste was recorded (in seconds). The paste was left in the sulcus for 2 min after which it was washed out by air and water spray [Figure 1a]. After paste removal, bleeding was recorded (in terms of yes or no) [Figure 1b].

**Impression Procedures**

Immediately following the assessment of bleeding, and time taken for application of material, a two-step putty wash technique using polyvinyl siloxane impression material combination of heavy body (Aquasil Soft Putty/Regular Set, Dentsply Detrey GmbH, Konstanz, Germany) and light body (Aquasil LV Ultra, Smart Wetting Impression Material, Dentsply, Detrey GmbH, Konstanz, Germany) was employed with a stock tray for each subject. In total, one impression was made from each subject to duplicate two stone models with die stone (Ultrarock, Kalabhai Karson Pvt Ltd., Mumbai, India). Impressions were poured between 1 and 3 h. One of the stone models was sent to laboratory for fabrication of metal ceramic crowns, and other model was used for measurement of gingival retraction.

**Measurement of Horizontal Gingival Retraction in Stone Models**

First, the die sectioning was done, then the dies were disked proximally with a rotary diamond disk to make transitional line angle (TLA) more prominent. Width (in mm) of the retracted sulcus was measured on all four surfaces: TLA - mesiobuccal (MB), TLA - distobuccal (DB), TLA - mesiopalatal (MP)/mesiolingual (ML), and TLA - disto palatal (DP)/dusto lingual (DL) under a travelling microscope with least count of 0.001 mm (Weswox Optik, The Western Electric and Scientific Works, Ambala CANTT, India) as the distance from the tooth to the crest of the gingiva. The examination table of the microscope was standardized using the transparent resin plate and spirit level assembly. A 2 mm standardized transparent resin sheet was attached to the upper surface of the surveying table, and over this, the die to be evaluated was placed. The menisci of the horizontal arms of spirit levels were verified for parallelism before recording measurements as described later [Figure 2a]. Amount of horizontal gingival retraction was recorded at four locations one for tooth receiving cord and other for expasyl paste [Figure 2b].

**Fabrication of Provisional Restoration**

The provisional restoration was fabricated by direct-indirect method using polymethyl methacrylate acrylic resin (DPI Self Cure Tooth Molding Powder, Dental Products of India, Burmah Trading Corporation Ltd., Mumbai, India). The provisional restoration was cemented with non-eugenol zinc oxide temporary cement (3M ESPE, Rely Xtm Temp NE, 3M ESPE AG, SEEFELD, GERMANY).

**Effect of Retraction Material on Soft Tissue Health**

Effects of two retraction materials on gingival health were measured at various follow-up intervals (baseline, 1 month, and 3 months). Immediately after cementation, first impression (baseline impression) was made using irreversible hydrocolloid (alginate) and poured in dental stone (Kalstone Kalabhai Karson Pvt Ltd, Mumbai, India). This model served as baseline model. Before baseline impression, clinical measurements were initially recorded immediately in terms of (a) bleeding on probing scoring as 0, 1, and 2 (0 - no bleeding, 1 - mild bleeding, 2 - moderate bleeding) and (b) plaque index scoring as 0, 1, 2, and 3 (0 - no plaque and 1 - a film of plaque adhering to the free gingival margin and adjacent area of the tooth. The plaque may be seen in situ only after application of disclosing solution or using the probe on the tooth surface, 2 - moderate accumulation of...
soft deposits within the gingival pocket or the tooth and gingival margin which can be seen with the naked eye, and 3 - abundance of soft matter within the gingival pocket and/or on the tooth and gingival margin). Using digital caliper (Digimatic Caliper, Mitutoyo, Japan), the greatest vertical distance from gingival margin to a fixed point on tooth as measured and compared with the values of 1st and 3rd month models to determine gingival recession. After 1 month and 3 months from baseline impression, second and third impressions were made and model was poured in dental stone. Before impressions, clinical measurements were recorded immediately in terms of (a) bleeding on probing scoring as 0, 1, and 2 (0 - no bleeding, 1 - mild bleeding, and 2 - moderate bleeding) and (b) plaque index scoring as 0, 1, 2, and 3 (0 - no plaque, 1 - a film of plaque adhering to the free gingival margin and adjacent area of the tooth. The plaque may be seen in situ only after application of disclosing solution or by using the probe on the tooth surface, 2 - moderate accumulation of soft deposits within the gingival pocket, or the tooth and gingival margin which can be seen with the naked eye, and 3 - abundance of soft matter within the gingival pocket and/or on the tooth and gingival margin), and (c) gingival recession (in mm). From the second and third impressions, stone models were poured to register the position of gingival margin after 1 month and 3 months of retraction procedure to determine gingival recession. To determine gingival recession, a digital Vernier caliper was used, a fixed point was marked on the tooth of 1st and 3rd month model, and the greatest vertical distance from the fixed point and gingival margin was measured and compared with baseline models. Amount of gingival recession was measured in mm [Figure 3].

RESULTS

All data were analyzed using the statistical program of social science version 18.0 Inc, Chicago, USA. The average retraction of the gingival sulcus between expasyl and plain cord retraction technique at TLA-MB, TLA-DB, TLA-MP/ML, and TLA-DP/DL was 0.610, 0.057, 0.107, and 0.253, respectively and statistically not significant [Table 1]. The mean time taken for application of expasyl retraction system (42.25 and 57.09 min) and plain retraction cord (109.83 and 112.06 min) in both anterior and posterior segment was statistically significant [Figure 4]. Bleeding using expasyl retraction system was only 5.1% (2 subjects) showed bleeding, whereas 74.4% (29 subjects) showed bleeding using plain retraction cord [Figure 5]. The division of plaque index scores [Table 2], bleeding on probing [Table 3], and mean gingival recession [Figure 6] signifies at all the time intervals and there is statistically significant difference between three.

DISCUSSION

There is minimal consensus cited in the literature regarding criteria for the evaluation of clinical efficacy with gingival retraction materials.[6-9] According to Shillingburg et al., 77% of offices surveyed used epinephrine-impregnated cords.[10] According to Donovan et al., 79% of the general dentists are using epinephrine.[11] According to Shaw and Krejci, 55% of the dentists surveyed were using epinephrine as their primary method of finish line exposure.[12] Although chemically impregnated cords are the most commonly used techniques for gingival tissue retraction, there are potential epinephrine reactions that can occur following its systemic absorption which include increased anxiety after cord placement, limb tremor, diaphoresis, headache, florid appearance, tachycardia, and elevated blood pressure.[13] However, there are many variables that make it difficult to predict the physiological effect. These variables include: the concentration of epinephrine absorbed from the cord; the length of time the cord was in the sulcus;
the condition of the gingival tissue; the presence of crevicular fluid or saliva; individual patient response; and drug interactions with tricyclic antidepressants, nonselective β-adrenergic antagonists, certain general anesthetics and cocaine. Therefore, recommendations have been made to either limit or avoid use of such epinephrine-impregnated retraction cords.

Ultrapak retraction cord has chain like construction of interlocking loops which lets the cord bend passively in any direction. Consistency of the cord whether it is twined or knitted is more important than the type of medicament used.

In addition to the soaking time, the saturation of the cords with the solutions largely depended on the wetting of the cords. In the present study, cord was soaked in saline solution to enhance the mechanical effect, and 20 min of soaking time was necessary for saturation of the cords before use, provided that air trapped within the cords was removed.

Expasyl has been developed to deal with impressions, seating of restorations, fitting rubber dams, and restoring class II, III, and V cavity difficulties, saving considerable amount of time for the practitioner and enhancing comfort for the patient. Previous studies have shown that gingival retraction was more with retraction cord than expasyl, and also inflammation and recession were more with retraction cord than expasyl.

In the present study, the subjects were assessed clinically and radiographically for the sound condition of both the abutments adjacent to the edentulous space. Subsequently, both these abutments were prepared for full coverage restoration with equigingival

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### Table 1: Comparison of mean horizontal gingival retraction in each retraction technique at different locations using chi square test

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### Table 2: Comparison of plaque index at one month and three months in each retraction technique using independent t test

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<th>χ² Value</th>
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### Table 3: Comparison of bleeding on probing scores at one month and three months in each retraction technique using independent t test

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technique was considerably less when compared to the time required for placement of plain retraction cord technique. Expasyl retraction technique is relatively user friendly and easy to master, whereas the retraction cord placement requires more skill and experience to master. In both the techniques, time required for placement was significantly less in anterior teeth than the time taken for posterior teeth. However, this variation was more in both retraction systems. This can be easily attributed to difficulty in accessibility and visibility in the oral cavity as we move from anterior to posterior segment. Absence of bleeding on removal of the retraction materials using expasyl retraction technique was 94.9% which provided excellent hemorrhage control as compared to plain retraction cord technique where only 25.6% provided hemorrhage control. This may be attributed to the increased concentration of aluminum chloride in expasyl retraction system (15%) as compared to plain retraction cord (0%). Further, the increased hemorrhage seen in plain retraction cord may be due to the disturbance of clot during its removal. Similar to previous histological studies, both the placement of cord and paste lead to reversible elevation in gingival index, suggestive of injury to the periodontium.\textsuperscript{[21-24]}

According to our study, the injury to the gingival tissues, based on gingival index and gingival recession, was more severe in retraction cord than paste. It could be due to the pressure applied during the cord application which is associated with the damage to the sulcular and junctional epithelium and underlying connective tissue.

A study by Van der Velden and De Vries in 1978 has shown that the epithelial attachment sustains injuries at a force of 1 N/mm\textsuperscript{2} while it ruptures at 2.5 N/mm\textsuperscript{2}. The pressure applied by the retraction cord in this region is between 5 and 10 N/mm\textsuperscript{2}. To avoid any damage to the epithelial attachment, gingival retraction should be accomplished under a pressure between 0.1 and 1 N/mm\textsuperscript{2}. According to our study, with expasyl retraction technique, it is possible to achieve adequate opening of the sulcus without damaging the epithelial attachment. However, the amount of pressure applied during gingival retraction was not assessed in the study. Single retraction cord technique was followed in all the cases; other retraction techniques such as double cord technique were not considered.

The AlCl\textsubscript{3} concentration in the injection-type expasyl is as high as 15% and is designed, especially for the purpose of hemostasis. Aluminum chloride solution acts as hemostatic agent and astringent. It has the ability to precipitate protein, constrict blood vessels, and extract fluid from tissues. It is highly soluble in water, freely soluble in alcohol, and also soluble in glycerin. It was suggested that a concentration >10% is hazardous to soft tissue.\textsuperscript{[23,25]} Although tissue injury caused by the high AlCl\textsubscript{3} content was not evident in this study, subjects enrolled in this study had healthy margins, to avoid damage to surrounding gingival tissues. Equigingival margins were preferred as it cause less tissue damage, if the tissue damage is more the epithelium will be more vulnerable to chemical trauma and gingival recession might result.\textsuperscript{[5]} Previous studies have suggested that a sulcus width >0.2 mm is necessary to obtain an accurate impression and that the impression should have a minimum thickness of 0.2 mm to resist deformation during pouring of the dental stone.\textsuperscript{[20]} In the present study, both the retraction materials produced sulcus width of >0.2 mm, but the amount of retraction produced by both these materials were almost similar, and statistically no significant difference was noted among them. Although at all four transition line angles expasyl retraction system showed slight increase in width of horizontal gingival retraction as compared to plain retraction cord, statistically there was no significant difference between the two (\(P < 0.05\)). This may be attributed to the action of plain retraction cord which is mechanical as compared to expasyl retraction system which has mainly chemical action (aluminum chloride enhances hemostatic action which also shrinks epithelial tissue further expanding the sulcus) on the gingival tissues. The amount of vertical gingival retraction and influence of distendability of gingiva, gingival thickness, and varied sulcus depth on the gingival retraction were not considered in the study. The time taken for application of expasyl retraction technique was considerably less when compared to the time required for placement of plain retraction cord technique. Expasyl retraction technique is relatively user friendly and easy to master, whereas the retraction cord placement requires more skill and experience to master. In both the techniques, time required for placement was significantly less in anterior teeth than the time taken for posterior teeth. However, this variation was more in both retraction systems. This can be easily attributed to difficulty in accessibility and visibility in the oral cavity as we move from anterior to posterior segment. Absence of bleeding on removal of the retraction materials using expasyl retraction technique was 94.9% which provided excellent hemorrhage control as compared to plain retraction cord technique where only 25.6% provided hemorrhage control. This may be attributed to the increased concentration of aluminum chloride in expasyl retraction system (15%) as compared to plain retraction cord (0%). Further, the increased hemorrhage seen in plain retraction cord may be due to the disturbance of clot during its removal. Similar to previous histological studies, both the placement of cord and paste lead to reversible elevation in gingival index, suggestive of injury to the periodontium.\textsuperscript{[21-24]} According to our study, the injury to the gingival tissues, based on gingival index and gingival recession, was more severe in retraction cord than paste. It could be due to the pressure applied during the cord application which is associated with the damage to the sulcular and junctional epithelium and underlying connective tissue.

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gingiva. However, the side effects of aluminum chloride were not assessed in the study. A cytotoxicity test and review of the literature indicate that an inflammatory cell response or cytotoxic reactions under a microscope can occur when high concentrations are used. It is possible that gingival damage may become evident when the reparative ability or tissue resistance of the host body is diminished. This emphasizes the need to develop biomaterials containing fewer chemical agents in the future. At all the time intervals, the plaque index, bleeding on probing, and mean gingival recession in the cord group were significantly greater than expasyl paste group. However, four subjects showed gingival enlargement with both plain retraction cord and expasyl paste. This may be attributed to the patients exhibiting poor oral hygiene.

**CONCLUSION**

The findings of the study indicate amount of horizontal gingival retraction obtained with the use of expasyl retraction paste which is almost similar in comparison to plain retraction cord. The study indicates expasyl retraction system appears to be a promising system for the control of hemorrhage, reduced clinical time for application. Whereas, at all the time intervals (1 month and 3 months follow-up), the effect of retraction system on soft tissue health (plaque index, bleeding on probing, and mean gingival recession) in the cord group was significantly greater than expasyl paste group. Hence, it can be concluded that for a given amount of retraction of the gingiva, expasyl retraction system is (i) easier to use, (ii) produced minimal bleeding on use, and (iii) produced minimal soft tissue health issues.

**REFERENCES**


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