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In Vitro Examination of the Pressure Caused by Different Techniques and Materials for Gingival Displacement

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Abstract

Statement of Problem: Gingival displacement is an important part of the impression procedure, but the pressure induced by different gingival displacement methods is unclear.

Purpose: The purpose of this in vitro study was to determine the pressure caused by different materials and methods on the gingival tissue and to compare the amount of displacement that occurs in the gingival tissue.

Material and Methods: A model was prepared with silicone impression material placed around a transparent acrylic resin model to replicate the dentogingival tissue junction. Four different displacement methods were applied to the gingival sulcus prepared on the model: astringent retraction paste, retraction cord (Cerkamed) and retraction gel (Ultradent) to be measured separately with single (0) and double cord (0 and 00) techniques. The pressure applied to the base of the sulcus during and 60 seconds after the insertion of the displacement agents into the gingival sulcus was measured with a pressure gauge (PowerLab; AD Instruments Pty Ltd). Furthermore, the displacement of the gingival sulcus during the applied pressure was recorded, and the correlation between the applied pressure and the resulting displacement was analyzed. The normal distribution of continuous variables was examined by using the Shapiro-Wilk W and Kolmogorov-Smirnov tests. The paired samples t test was used for dependent groups when the normal distribution condition was met; otherwise, the Wilcoxon test was used (α=.05). In the comparison of continuous variables with more than 2 independent groups, the ANOVA test was used when the normal distribution condition was met; otherwise the Kruskal-Wallis test was used (α=.05). In the comparison of 2 quantitative variables, the Pearson correlation test was used when the normal distribution condition was met; otherwise, the Spearman correlation test was used (α=.05).

Conclusions: No statistically significant difference was observed in terms of the applied pressure among the 3 displacement materials used. The pressure applied by the retraction paste used (Astringent retraction paste, 3M) was higher than that of

other methods. Furthermore, a correlation between the applied pressure and the resulting displacement was observed for the gel and cord techniques. However, such a correlation was not observed for the retraction paste.

Keywords: Gingival Retraction, Pressure, Gingival Sulcus Model.

Clinical Implicatıons: The pressure applied by the retraction paste, gel and the cords that are generally used in gingival retractions does not cause irreversible damage for the gingival sulcus. Gingival retraction materials applied to the sulcus in accordance with the manufacturer's instructions do not cause biological damage due to the pressure created by the gingival retraction materials.

Introduction

In prosthetic treatment, maintaining periodontal health and accurate margin adaptation are as important as function and aesthetics [1], and careful management of the soft tissues is essential during impression making [2]. Accurate impressions require the displacement of soft tissue and the removal of fluids and debris [3], to reveal the finish line during impression making [1].

The lateral displacement of gingival tissues increases the volume of the impression material, preventing tearing, while vertical displacement exposes the apical unprepared tooth structure [4]. Effective gingival displacement, without damaging the periodontal tissues, is essential for the long-term success of the restoration [2].

Some gingival displacement methods are painful, requiring anesthesia, and may lead to postoperative tooth sensitivity or gingival recession, which will adversely affect patient comfort [5]. An atraumatic gingival displacement technique is required to avoid disadvantageous situations [2,5,6]. Different materials and methods have been developed for gingival displacement and have been classified as mechanical, chemomechanical, surgical, and laser applications [7-9].

Unsuitable displacement methods may damage the gingiva, especially in patients with a thin gingival phenotype [10]. However, evidence for the traumatic effect caused by the pressure applied in gingival displacement is sparse [11]. The pressure applied during the placement of displacement cords, still the most popular method, to the gingival sulcus is based on the clinician's judgement and experience, which may lead to the application of excessive pressure [12].

The pressure generated by the popular double cord technique has been compared with that of other methods [13]. Advantages of the double cord technique include minimizing the tearing and deformation of the impression and improving hemorrhage control [13,14]. Two displacement cords of different sizes are used in this technique. The smaller cord is placed in the apical part close to the junctional epithelium, and the other, which is two sizes larger, is placed more occlusally [15]. Displacement pastes and gels have recently been introduced as a cordless technique and have become popular because they save time, are straightforward to apply, are less invasive than cords, and thus increase patient comfort [16,17].

The aim of this study was to compare the pressure caused by three different displacement methods (conventional cord, paste, and gel) on replicated gingival tissues. The research hypotheses were that gingival displacement cords exert more pressure on the gingival sulcus than other methods and that the pressure exerted by usingthe single cord and double cord techniques would be similar.

Material and Methods

A Ø8-mm-circular tooth model for impression making was formed from a transparent acrylic resin (tdv dental) material and covered with a silicone impression material (elite HD A type; Zhermack) to simulate the gingiva and form a 3-mm-deep gingival sulcus as described by Bennani et al [11]. The model allowed the gingival displacement materials to be removed from the sulcus and observation of the application of the displacement (Fig. 1).

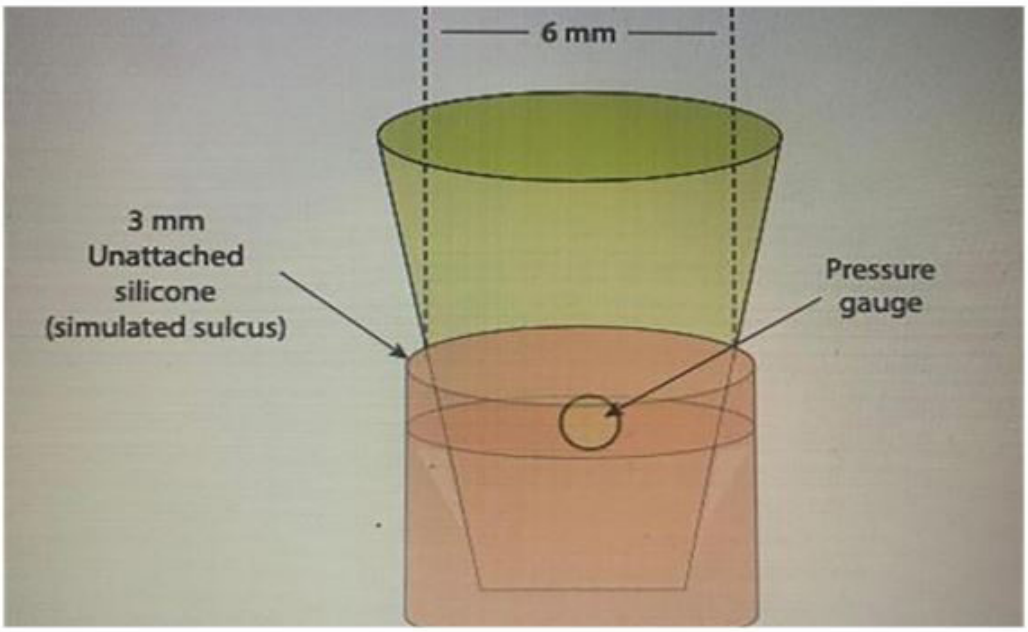

Figure 1: Gingival sulcus model.

Three types of displacement agents were placed into the simulated gingival sulcus: displacement paste (Astringent retraction paste; 3M), displacement cord (cerkamed), and displacement gel (Ultradent Dental Products, Inc). The displacement cords were applied by using both the single and double cord techniques (Table 1).

Material	Manufacturer
A type silicone	Zhermack Elite HD+ A type
Clear silicone	Tdv dental
Retraction paste	Astringent retraction paste, 3M ESPE.
Retraction gel	Viscostat clear 25% aluminum chloride gel, Ultradent.
Retraction cord	Cerkamed retraction cords.

Table 1: Materials used in the study and the manufacturer's information

Compared with cords, retraction paste is less traumatic for tissues, is easy to apply, exerts low pressure, and improves patient comfort. Retraction gels provide advantages similar to those of a paste and are viscous but spreadable. Currently, retraction cords are still the most popular method of ensuring accessibility to the studied region [18].

All materials were used in accordance with the manufacturer's instructions, and a cord packer (1.5 mm; cerkamed) was used to place the cords into the sulcus. The paste was applied to the sulcus by placing the 1-mm applicator tip into the sulcus with a composite resin gun dispenser. The displacement gel was applied in the same way as the paste.

A single operator (B.T.) measured the pressure at the base of the gingival sulcus area with a pressure gauge (PowerLab; ADınstruments Pty Ltd) capable of sampling pressure 1000 times per second located. After each test, the polyvinyl siloxane component was removed, cleaned of residue with microbrushes (Orange Solvent; Dux Dental), and dried.

The number of tests for each displacement method (n=35) was determined with a software program (G*Power; Heinrich-Heine-Universität Düsseldorf) at a power of 80% and a confidence level of 95%. Each displacement group was tested 35 times, and maximum, minimum, median injection pressure (kPa), and postinjection pressure (kPa) were recorded with the software program and display system. Postinjection pressure was determined by taking the mean of the pressures up to 60 seconds after the removal of the applicator tips and cord packers. A digital measuring microscope with a display (ISM-DL300) was used to observe the amount of displacement that occurred in the silicone model.

A statistical software program (IBM SPSS Statistics, v20; IBM Corp) was used for the statistical analyses. The data were calculated as mean, standard deviation, median, minimum, and maximum values, percentage, and number. The normal distribution of continuous variables was examined with the Shapiro-Wilk W and the Kolmogorov-Smirnov tests. For comparisons between 2 dependent groups, the paired samples t test was used when the normal distribution condition was met and the Wilcoxon test was used when it was not met. In the comparison of continuous variables with more than 2 independent groups, the ANOVA test was used when the normal distribution condition was met and the Kruskal-Wallis test when it was not met.

Post hoc tests after the ANOVA test were performed using the Tukey test when the variances were homogeneous and the Tamhane T2 test when the variances were not homogeneous. Post hoc tests after the Kruskal-Wallis test were performed using the Kruskal-Wallis 1-way ANOVA test. In the comparison of 2 quantitative variables, the Pearson correlation test was used when the normal distribution condition was met, and the Spearman correlation test was used when the correlation was not achieved (α=.05) (Table 3).

Results

The mean pressure in the gingival sulcus for the 3 different types of displacement materials and the double cord technique during and 60 seconds after the application is presented in Table 2. For all materials, the pressure during injection was higher than after injection. The astringent paste had the highest pressure measurements (389.88 kPa), significantly higher than those of the other groups (P<.05) during and after application, followed by the double cord technique of the cerkamed cord (0 and 00), the single cord technique (0), and the gel (92.49 kPa). However all displacement materials applied pressure at atraumatic levels within the capacity of epithelial adhesion.

	Injection pressure (kPa)				**Post injection pressure (kPa)**			
Materials tested (n=35)	Minimum	Maximum	Median	Median displacement (mm)	Minimum	Maximum	Median	Median displacement (mm)
Astringent paste	261.963	325.113	296.99	1.6	214.966	71.52	264.25	1.8
Cerkamed (singlecord)	87.84	140.253	114.113	1.1	78.97	134.873	106.02	1
Cerkamed (doublecord)	77.31	148.916	120.02	1.1	77.116	147.2766	117.31	1
Ultradent	78.276	130.596	103.61	1	71.52	124.14	95.89	1

Table 2: Injection and post-injection pressure values for Astringent, Cerkamed (single cord), Cerkamed (Double cord) and Ultradent in kPa.

Table 3: Spearman's test result.

Astringent paste	Spearman's rho	Injection pressure	R	0.122	0.012
			P	0.485	0.946
			N	35	35
		Post injection pressure	R	0.238	0.064
			P	0.168	0.714
			N	35	35
Cerkamed (Single)	Spearman's rho	Injection pressure	R	.707**	.390*
			P	0	0.02
			N	35	35
		Post injection pressure	R	.501**	.431**
			P	0.002	0.01
			N	35	35
Cerkamed (Double)	Spearman's rho	Injection pressure	R	.865**	.836**
			P	0	0
			N	35	35
		Post injection pressure	R	.784**	.854**
			P	0	0
			N	35	35
Ultradent	Spearman's rho	Injection pressure	R	.812**	.800**
			P	0	0
			N	35	35
		Post injection pressure	R	.675**	.660**
			P	0	0
			N	35	35

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

When the pressure differences in the model during application and the displacement values on the silicone model were analyzed, no statistically significant difference was found between the Cerkamed and Ultradent products (P>.05). The pressure differences and the resulting displacement values were statistically significant for the astringent displacement paste. (P<.05).

When the correlation of pressure with gingival displacement capacity was examined, the Cerkamed and Ultradent products acted similarly (P>.05). As the pressure applied for these materials increased, the cavity formed in the silicone model increased. No correlation was observed between pressure formation and cavity formation for astringent. The correlation with pressure of the expansion caused by the Cerkamed and Ultradent products and the graph of displacement caused by astringent against pressure are presented in Figures 2 and 3.

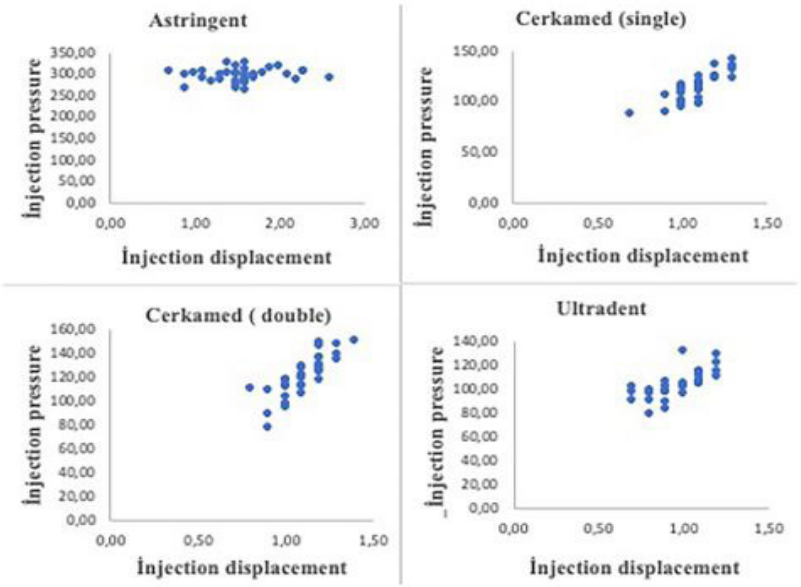

Figure 2: Correlation between expansion in sulcus during injection.

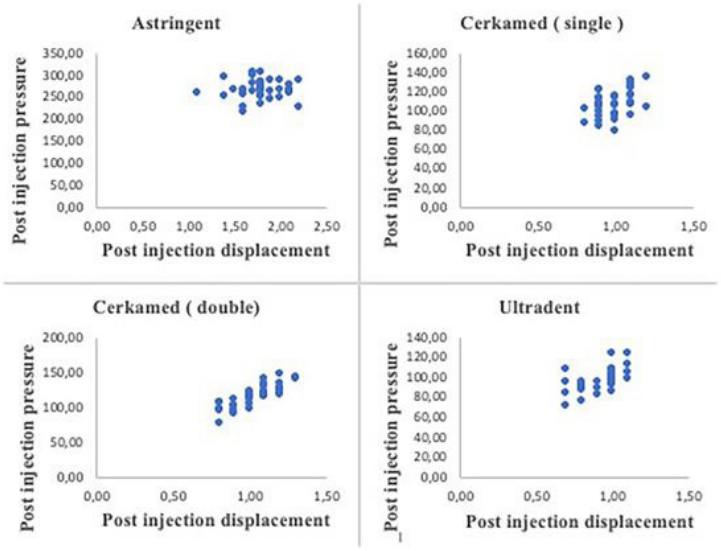

Figure 3: Correlation between post-injection pressure and the resulting dilation.

Discussion

Studies have been conducted on the effects of gingival displacement on epithelial attachment [12]. In addition to the chemical structure of the materials applied, the effect of the pressure applied has been reported to be significant [19]. However, clinical studies on gingival displacement are problematic both technically and ethically, and in vitro studies on the pressure applied on gingival tissues are sparse [20]. The model used in the present study created paths for the materials used to escape as the pressure was applied [11], imitating the capacity of excess displacement material to escape the sulcus during clinical application. It was assumed that the model, which imitated the prepared tooth structure, transmitted the pressure evenly along the artificial junctional epithelium because of the cylindrical geometry.

The impression stage is critical to record tooth preparations and transfer them to the dental laboratory. Many techniques and materials have been described, and several methods are used routinely in clinical practice [21]. In the present study, the pressures applied by the displacement paste, gel, and cords were determined and a correlation was established between the pressure applied and the resulting tissue displacement.

According to the study results, the first research hypothesis was accepted because the astringent gel applied significantly more pressure than the other materials. The second research hypothesis was rejected because no significant difference was found in the pressure applied by the displacement cords applied by single or double cords.

Marco Dederichs et al [17] tested 6 retraction cords of different sizes, 4 different pastes, and 2 different types of gel materials and reported that the pressure generated by Expasyl was significantly higher than the pressure generated by the cord and gel systems. The results of the current study also determined that the paste astringent material applied significantly higher pressure. Marco Dederichs et al [17] also reported that the applied pressures increased significantly with the increasing diameter of the cords. However, in the present study, the double-cord technique was statistically similar (P>.05) to the single cord technique, possibly because, after the first placed cord created a certain displacement, the second cord directed the pressure horizontally.

Bennani et al [10] reported that the pressure generated by KnitTrax displacement cords was significantly higher than with Expasyl, reporting pressures up to 5396 kPa generated by displacement cords. However, these high values may have been a result of an experimental design as a closed box.

In another study by Bennani et al, [11] an experimental design similar to the present design was used, reporting no significant difference between the materials used in terms of pressure applied. However, while the displacement caused by the pressure applied increased with the pressure applied for cordless techniques, the cavity formation decreased with the pressure applied for the cords.

In the present study, the correlation between the pressure applied and the cavity formation is presented in Figures 2 and 3. The expansion caused by the displacement cords and the Ultradent product increased with the pressure applied. However, the expansion achieved at lower pressure values with the single-cord technique could be achieved at higher pressure values with the double-cord technique, which can be explained by the fact that the expansion caused by the cord technique was only obtained from the physical volume of the cord. In the double cord technique, the effect of the first cord was limited to making the area where the second cord would be placed more stable and hemostatic. Therefore, cavity formation occurred depending on the volume of the second cord placed, and no significant difference was observed. The correlation between the pressure value of the astringent paste and the resulting expansion was observed to be variable depending on the technique used. The reason for this situation may be the instability of the flow rate of the material from the gun and the loss of power in any manipulation that occurs after placement.

Limitations of this study included that since the measurements were made on an in vitro model, the effect of fluid in the gingival sulcus and the degree of tissue elasticity were not replicated.

Conclusions

Based on the findings of this in vitro study, the following conclusions were drawn:

1. All materials displaced the simulated gingival tissue in accordance with the expected clinical parameters.
2. The pressure measured for all materials, including the maximum pressure values, was below the physiological maximum for the gingiva.
3. The pressure applied by the astringent displacement paste was significantly higher than that applied by the other materials.
4. While the expansion power of the astringent paste did not correlate with the pressure applied, the pressure applied for Cerkamed cords and the Ultradent product and the expansion achieved were positively correlated.

References

1. Shillingburg HT, Hobo S, Whitsett LD, Jacobi R, Brackett S (1997) Fundamentals of fixed prosthodontics: Quintessence Publishing Company.

2. Azzi R, Tsao T, Carranza Jr F, Kenney E (1983) Comparative study of gingival retraction methods. The Journal of prosthetic dentistry 50: 561-565.

3. Donovan T, Gandara B, Nemetz H (1985) Review and survey of medicaments used with gingival retraction cords. The Journal of prosthetic dentistry 53: 525-531.

4. Albaker am (2010) Gingival Retraction-Techniques and Materials: A Review. Pakistan Oral & Dental Journal: 30.

5. Hansen PA, Tira DE, Barlow J (1999) Current methods of finish-line exposure by practicing prosthodontists. Journal of Prosthodontics 8: 163-170.

6. Van der Velden U (1979) Probing force and the relationship of the probe tip to the periodontal tissues. Journal of Clinical Periodontology 6: 106-114.

7. Baba NZ, Goodacre CJ, Jekki R, Won J (2014) Gingival displacement for impression making in fixed prosthodontics: contemporary principles, materials, and techniques. Dental Clinics 58: 45-68.

8. Al-Ani A, Bennani V, Chandler NP, Lyons KM, Thomson WM (2010) New Zealand dentists' use of gingival retraction techniques for fixed prosthodontics and implants. NZ Dent J 106: 92-96.

9. Ahmed SN, Donovan TE (2015) Gingival displacement: Survey results of dentists' practice procedures. The Journal of prosthetic dentistry 114: 81-85.

10. Bennani V, Inger M, Aarts JM (2014) Comparison of pressure generated by cordless gingival displacement materials. The Journal of prosthetic dentistry 112: 163-167.

11. Bennani V, Aarts JM, Schumayer D (2016) Correlation of pressure and displacement during gingival displacement: an in vitro study. The Journal of prosthetic dentistry 115: 296-300.

12. Phatale S, Marawar P, Byakod G, Lagdive SB, Kalburge JV (2010) Effect of retraction materials on gingival health: A histopathological study. Journal of Indian Society of Periodontology 14: 35.

13. Cloyd S, Puri S (1999) Using the double-cord packing technique of tissue retraction for making crown impressions. Dentistry today 18: 54-59.

14. Abadzhiev M (2009) Comparative research of the subgingival impression quality by fixed prosthesis using one and double cord retraction technique. Journal of IMAB-Annual Proceeding (Scientific Papers) 2: 52-54.

15. Kannan A, Venugopalan S (2018) A systematic review on the effect of use of impregnated retraction cords on gingiva. Research Journal of Pharmacy and Technology 11: 2121-2126.

16. Lesage P (2002) Expasyl: protocol for use with fixed prosthodontics. Clinic 23: 97-103.

17. Dederichs M, Fahmy MD, Kuepper H, Guentsch A (2019) Comparison of gingival retraction materials using a new gingival sulcus model. Journal of Prosthodontics 28: 784-789.

18. Shetty M, Gaurav S, John N, Pai U, Shetty NA (2021) Qualitative Analysis of Magic Foam and the Conventional Gingival Retraction Cord System in Dental Impressions. World 12: 480.

19. Kamath R, Sarandha D, Baid GC (2011) Advances in gingival retraction. International Journal of Clinical Dental Science 2.

20. Raghav D, Singh S, Kola MZ, Shah AH, Khalil HS, Kumar P (2014) A comparative clinical and quantitative evaluation of the efficacy of conventional and recent gingival retraction systems: An in vitro study. Europ J Prosthodon 2: 76.

21. Ferrari M, Cagidiaco MC, Ercoli C (1996) Tissue management with a new gingival retraction material: a preliminary clinical report. The Journal of prosthetic dentistry 75: 242-247.