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THE EFFECT OF VARIOUS RETRACTION MATERIALS ON COLOR STABILITY OF ARTIFICIAL GINGIVA AND DENTINE; AN IN-VITRO STUDY

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ABSTRACT

Objectives: The aim of this study is to evaluate the effects of three different retraction agents on the color of dentin and artificial gingiva following the gingival retraction.
Materials and Methods: 36 lower anterior incisors which were embedded in polymethyl-methacrylate resin 3mm below the enamel-cement junction were prepared with a 1.5 mm chamfer finish line. The margin of each sample was waxed 1mm above the enamel-cementum junction and periodontal probe was used to provide the artificial gingival pocket. For each specimen, silicone indexes were prepared to make an artificialgingiva. Following the removal of the waxes, 3 mm artificial gingiva was created by a silicone material. Then three different retractionmethods (Retraction cord + %25 aluminum chloride, retraction cord + %20 ferricsulphate and retraction paste including 15% aluminum chloride) were applied for 180 seconds and then rinsed for 30 seconds. Retraction materials were completely removed from the specimens surfaces. Color measurements were applied before and after the retraction by Easy shade device from three points of buccal surfaces that were indicated before the retraction. Polymethyl-methacrylate block was used for calibration of the Easy Shade device. After the calculation of ΔE values, the discoloration of the dentine and artificial gingiva was determined. Data were analyzed using one-way ANOVA and Tukey honestly significant difference (HSD) test (a=.05).
Results: For the artificialgingiva, application of the retraction paste showed statistically lowest values in comparison to the other methods P(sig.):0,00<0,01). For the dentine, retraction cord + %25 aluminum chloride showed statistically significant lower ΔE values in comparison to retraction cord + %20 ferricsulphate, but application of the retraction paste including %15 aluminum chloride did not show statistically significant difference compared to the other methods.
Conclusion: The retraction solutions containing ferric sulphate caused discoloration both in dentineand also in the gingiva.

INTRODUCTION

It is essential for the clinicians to manage the temporary deflection of the gingival tissues which is defined as gingival retraction before the impressions of subgingival crowns and cervical lesions in order to ensure a high marginal quality by precisely exposing the finish lines (Benson, 1986 and Perakis, 2004). There are several gingival retraction methods such as mechanical, chemical, surgical or a combination of all (Al-Ani, 2010). Among the mentioned methods, the mechano-chemical method is the most preferred one using the retraction cords impregnated or soaked in the homeostatic agents.

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In this method, the retraction cords displace gingiva laterally and vertically, while the agents prevent or control hemorrhage (Bowles, 1991). The most commonly used medicaments for gingival retraction include buffered aluminum chloride, aluminum sulfate, aluminum potassium sulfate, ferric sulfate and epinephrine-impregnated cord (Nemetz, 1999). Among the mentioned agents, aluminum chloride, aluminum sulfate, aluminum potassium sulfate, and ferric sulfate are metal salts that precipitate tissue proteins and prevent capillary bleeding, thereby provide contraction of the gingival tissues (Jokstad, 1999 and Felpel, 1997). However, it is speculated in the literature that these agents may change the color of dentin. According to a recent study by Conrad *et al*, the use of gingival retraction fluids containing ferric sulphate caused a black internalized discoloration of dentin under translucent

porcelain restorations (Conrad, 2009). In another study, it was reported that owing to its iron content, ferric sulfate stained the gingival tissue yellow-brown to black color for a few days after its use (Wassell, 2002). It is possible to achieve information regarding the discoloration of dentin, but there isn't yet any data published on the literature about the effects of these agents on the artificial gingiva. Therefore, the aim of this study is to determine the effects of three different retraction medicaments on the color of dentin and artificial gingiva following the gingival retraction.

MATERIAL AND METHODS

Preperation of specimens

36 lower anterior incisors in similar size and shape were selected for this study. Teeth were embeded in a polyvinyl chloride (PVC) ring (2,5mm diameter and 27,0mm height) using polymethyl methacrylate resin (Meliodent, Hereaus Kruzer) 3mm below the enamel-cement junction (Fig. 1).

Fig. 1. Anterior incisors embeded into the acrylic resin blocks

Samples were prepared with a 1.5 mm chamfer finish line. The finish line was designed to be at the enamel-cementum junction. Samples were prepared by a single practitioner for providing standardization. After the preparation, margin of the each sample was waxed 1mm above the enamel-cementum junction. And periodontal probe was used to provide the artifical gingival pocket (Fig. 2).

Fig. 2. Gingival waxing and tooth preperation

For each specimen, silicone indexes were created to make artificial gingiva. After that the waxes were removed, 3 mm artificial gingiva was produced by Laboratory Elastic type A-Silicone material (Gingifast, Zhermack). (Fig. 3).

Fig. 3a. Silicon indexies for each specimen, Fig. 3b. Arrangement of the artificial gingiva

Application of retraction materials and solutions

36 specimens randomly were divided into three groups for applying the retraction materials. The retraction materials, their contents and implementing procedures were shown in Table 1. Retraction materials were applied for 180 seconds and then rinsed for 30 seconds. Retraction materials were compeletly removed from the specimens surfaces.

Color measurements

Color changes were measured before and after the application of the retraction materials and solutions by Easyshade (Vita) device from three points of buccal surfaces that were indicated before the retraction. Measurements were used on a white ground with a 90 ° angle between the tip of Easyshade device and margin finish line. When the color of artificial gingiva was measured, polymethylmethacrylate block had been used for calibration of the Easyshade Device.

The avarages of the l*a*b values obtained before and after the retraction procedures were recorded for each specimen. Then ΔE values were calculated according to the formula.

$$\Delta E^*_{ab} = \sqrt{(L^*_2 - L^*_1)^2 + (a^*_2 - a^*_1)^2 + (b^*_2 - b^*_1)^2}$$

Discoloration of the dentine and artificial gingiva was determined. Data were analyzed using one-way ANOVA and Tukey honestly significant difference (HSD) test(a=.05).

RESULTS

Tables 2 and 3 show ANOVA test performed for the groups, respectively. Table 4 and 5 present the statistical analysis identified with the Tukey HSD tests for artificial gingiva and dentine, respectively. For artificial gingiva Group III (Retraction Paste %15 AlCl3) retraction material showed significantly lowest values in comparison to the other groups (P(sig.):0, 00<0,05). It was followed by Group I (Cord+Viscostat Clear %25 AlCl3) and Group II (Cord+Viscostat %20 Ferric Sulphate). For dentine discoloration, Group I (Cord+Viscostat Clear %25 AlCl3) showed significantly lower ΔE values in comparison to Group

Table 1. Contents of the retraction materials

	Retraction Material Contents	Product Name	Manufacturer
Group1	Cord+%25Aluminium chloride	Ultrapak+Viscostat Clear	Ultradent, ABD
Group2	Cord+%20 Ferricsulphade	Ultrapak+Viscostat	Ultradent, ABD
Group3	Retraction Paste (15% 25Aluminium chloride)	Astringent Retraction paste	3M Espe, ABD

Table 2. Mean Values and standart deviation of Δ

ArtificialGingiva	Groups	N	Mean	Std. dev.	Std. Hata	Minimum	Maximum
	Group I	12	9,0900	1,20402	0,34757	7,48	11,48
	Group II	12	12,2475	2,17404	0,62759	8,52	15,28
	GroupIII	12	6,3108	1,69610	0,48962	3,11	9,22
	Total	36	9,2161	2,98248	0,49708	3,11	15,28
Dentine	Group I	12	6,1758	2,43521	0,70299	2,98	11,22
	Group II	12	9,3800	2,64119	0,76245	5,30	14,68
	GroupIII	12	7,6792	2,17984	0,62927	4,27	10,96
	Total	36	7,7450	2,70404	0,45067	2,98	14,68

Table 3. One-way ANOVA results for the groups

		Sum of Squares	df	Mean Square	F	Sig.
ArtificialGingiva	Between Groups	211,750	2	105,875	35,086	0,000
	Within Groups	99,582	33	3,018		
	Total	311,332	35			
Dentine	Between Groups	61,678	2	30,839	5,239	0,011
	Within Groups	194,236	33	5,886		
	Total	255,915	35			

Table 4. Mean values of ΔE with statistical comparision using Tukey HSD for artificial gingiva

Artificial Gingiva	Group	Subset for alpha = 0.05	
Tukey HSD(a)	III	6,3108	a
	I	9,0900	b
	II	12,2475	c
	Sig.	0,001	

Table 5. Mean values of ΔE with statistical comparision using Tukey HSD for dentine

Dentine	Group	Subset for alpha = 0.05			
		1		2	
Tukey HSD(a)	I	6,1758	a		
	III	7,6792	ab	7,6792	ab
	II			9,3800	b
	Sig.	0,296		0.214	

II(Cord+Viscostat %20 Ferric Sulphate), whereas no statistically significant differences were observed between Group III(Retraction Paste %15 AlCl3) and the other groups (P(sig.):0,20<0,05).

DISCUSSION

Marginal adaptation is a critical factor for the longevity of fixed prosthetsis. For an adequate marginal fit, gingival retraction provides the clinicans obtain proper impressions and casting models. Inaccurate marginal fit may give rise to periodontal tissue inflammation and risk of seconder caries especially for subgingivally located crown margins (Felton, 1991). In some circumstances like anterior region restorations with esthetic demands, retention requirements of clinically short crowns, restoration of root caries and cervical abrasion and treatments of root sensitivity, subgingival margins should be preferred (Acar, 2014; Padbury, 2003). For acceptable impressions, displacement of gingival tissues, management of hemorrhage and gingival fluid should be proceeded (Rosenstiel, 2006; Donovan, 2004 and Baharav, 2004). Mechanical or mechanochemical methods are widely prefered by clinicians where displacement cords are used alone or with hemostatic agents (Johnson, 2010 and Beier, 2009).

Various types of gingival retraction displacement cords and caps, gingival retraction pastes and gels, application methods and impregnation medicaments have been reported. Recently, cordless techniques with retraction pastes or gels have been introduced. Application of the retraction pastes are time saving and more comfortable while being minimally invasive compared to conventinal retraction methods (Albaker, 2010). Retraction pastes commonly include 15% aluminium chloride excipient, mica minerales and kaolin. In the present study, the effect of different retraction materials on discoloration of dentine and artificial gingiva was evaluated. Wostman *et al*, (Wostmann, 2009) reported that animal studies or clinical trials were necessary for evaluation of the gingival retraction phenomenon for not being possible to be simulated by laboratory procedures. Since the animal and human in vivo experiments were rather costly, they decided to work on a semi-clinical model based on the jaws of freshly slaughtered cows. In the present study, we simulated the artificialging ivaaround prepared dentine. One limitation of the current experiment is the lack of blood pressure in the gingival area during impression making. Thus, the results of this study have to be interpreted carefully as the testing design limits its significance compared to the clinical situation. Epinephrine, ferric sulphate and aluminium chloride are widely used

medicaments to stop haemorrhage in the gingival retraction procedures. Aluminium chloride (AlCl3) and Ferric sulphate (Fe(SO4)3) are metal salts that lead up to proteins and provide contraction in gingival tissues that prevent haemorrhage. Epinephrine causes local vasoconstriction in gingival sulcus; however epinephrine has relatively minimal side effects such as tachycardia, increased respiratory rate, hypertension and anxiety. Hence the use of epinephrine may be contraindicated for the patients with cardiovascular disease (Prasad, 2011). The materials we used in our study are commonly preferred solutions in clinical practice. Materials were applied according to the manufacturers recommendations, 3-5 min. Application periods were recommended we applied 3 min. retraction period the main reason of that is to prevent the irreversible gingival displacement.

Commonly used gingival retraction medicaments have acidic pH values (0.7-3.0) which might dispose the smear layer. Disposal of the smear layer may affect bond strength and longevity of the restoration as well as bacterial invasion into the dentine tubules. Gingival medicaments with acidic iron containing etch dentine unwittingly and that can occured physical resorption of iron into the porous demineralized dentine (Prasad, 2011; Kuphasuck, 2007 and Land, 1994). Due to ferric ions' affinity to teeth surfaces, ferric sulphate stains the gingival tissue from yellow-brown to black colour within a few days (Hattab *et al*., 1999; Strangel *et al*., 1996; Sulieman *et al*., 2005 and Watts, 2001). Aluminium chloride is an agent that acts by precipitation of tissue proteins but causes less vasoconstriction than epinephrine. It is one of the least irritating among all the medicaments used for impregnating retraction cords (Masek *et al*., 2005). The null hypothesis that the retraction methods or materials tested would show no significant difference in respect to discolouration was rejected. In the literature lots of researchers reported that the retraction materials and solutions could affect the colour of the dentine and gingiva. In the present study, we tried to simulate the clinical retraction procedures.

Anterior lower incisors were preferred because of their small anatomical structures, so the discolouration of the dentine could easily be observed. In the recent years, spectrophotometers and colorimeters came into use for dental clinicians. On behalf of different colour tabs, a virtual unmistakeable number of tooth colourations could be measured. Hence the colour measurements became more objective and foreseeable; colour data collection became easier and more reliable than naked eye. So that in our study we have used VITA EasyShade Compact electronic colour measuring device which is prevalently preferred in most of the researches (Waltmann, 2012; O'Brien, 2002 and Craig, 2002). CIE l*a*b values that are defined by CommisionInternationale d'Eclairage for characterising the colour difference value are attained from the device. Therefore ΔE values which are featured a comparative colour change between replicable colour measurements are calculated easily. Actually, CIE l*a*b is a popular and commonly preferred colour system in many studies. In this system, ΔE value of 3.7 is considered clinically noticeable (Ertas, 2006). In the present study, colour change values for all the retraction materials were greater than 3.7 which means that the discolourations tested was visually noticeable. Lighting condition and the background of the area on which the specimens were measured throughout the colour measurement could have effected the metrics (Guler, 2005). In our study, we used a white background and day light during the measurement. According to our results, aluminium chloride solution showed minimal discolouration in dentine compared to ferricsulphate solution. Discolouration of the ferric sulphate solution might be due to its iron content. As the rate of the aluminium chloride is lower in retraction paste (15%) than Viscostat Clear (% 25), the retraction paste showed minimal change in colour which is in accordance with theliterature. On the other hand, retractionpaste showed higher discolouration then Viscostat Clear (25%) in dentine which may be the result of the presence of mica minerals and kaolin within the retraction paste. Following the preparation of the teeth, dentine tubules could be effected more than the gingival tissues. As a conclusion, it could be reported that using ferric sulphate solutions may cause discolouration both in dentine and gingiva. Hence the clinicians should keep in mind the risk of colour changes in gingival and dentine tissues especially in the anterior regions when choosing the retraction materials and solutions. Despite the results of this study, further in-vivo studies subjecting the discolouration caused by retraction materials should be explored.

Conclusion

Within the limitations of this study following conclusions were drawn; The solution including aluminium chloride caused minimal discolouration in the artificial gingiva. Discolouration of gingiva was in direct proportion to aluminium chloride rate of the solutions. Retraction paste (%15) showed the lowestgingivalcolour change whereas ViscostatClear (%25) showed the least change of colour in dentine. Nevertheless ferric sulphate containing retraction solutions caused discolouration not only in dentine but also in the gingiva.

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