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Short Communications

Evaluating the effect of dentin surface pretreatment on the static contact angle of a drop of a bonding agent: an in vitro study

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Abstract

Introduction: The aim of this study was to investigate the effect of dentinal pretreatment on the static contact angle of a bonding agent as a measure of dentin surface wettability.

Materials &Methods: Twenty mid-coronal dentin surfaces were prepared and randomly allocated to four groups (n=5) according to the priming solutions. All segments were etched with 35% phosphoric acid gel for 15 s, rinsed for 30 s and dried. Each group was rehydrated with 10 µL of distilled water, 0.2 % chlorhexidine, 70% ethanol and 5.25% Sodium Hypochlorite respectively and the excess solution was removed after 60 sec using an absorbent paper. Using a micro syringe, a droplet of the Adper Single Bond 2 was placed on each prepared surface. Then the profile and the static contact angle of the droplet were analyzed with a video-based optical contact angle measuring system. The statistical analysis was performed using One-way ANOVA and Dunnett's t tests ($p<0.05$).

Results: There was a statistically significant difference between the water and sodium hypochlorite groups which indicates the negative effect sodium hypochlorite may have on dentinal surface energy. ($p=0.013$). The differences between the water and ethanol groups ($p=0.168$) and between the water and chlorhexidine groups ($p=0.665$) were not significant.

Conclusion: The use of 5.25% sodium hypochlorite as a priming solution in bonding procedure is not recommended. There is no improvement in dentinal surface wettability by using 70% ethanol or 0.2% chlorhexidine instead of water and the recommendation for use of any of the two should be based on other long-term or short-term effects they may have on the bonding procedure.

Keywords: Chlorhexidine, Dental bonding, Ethanol, Sodium hypochlorite, Wettability

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بررسی اثر آماده سازی سطح عاج بر زاویه تماس استاتیک عامل اتصال دهنده عاجی

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چکیده

مقدمه: در مطالعه حاضر تاثیر آماده سازی سطح عاج بدنبال شستشو با چند محلول بر زاویه تماس استاتیک عامل باندینگ به عنوان معیار سنجش میزان مرطوب شوندگی سطح عاج مورد بررسی قرار گرفته است.

مواد و روش ها: بیست سطح عاجی از ناحیه میانی تاج تهیه و آماده سازی گردیده و به صورت اتفاقی به چهار گروه پنج تایی تقسیم شدند. تمام نمونه ها با استفاده از ژل اسید فسفریک ۳۵٪ به مدت ۱۵ ثانیه اچ شده، سپس به مدت ۳۰ ثانیه شستشو داده شده و خشک شدند. گروه های مورد مطالعه شامل آب (کنترل)، کلرهگزیدین۰/۲ ٪ ، اتانول ۷۰٪ و هیپوکلریت سدیم ۵/۲۵٪ بوده و نمونه های هر گروه با ۱۰میکرولیتر از محلول مرتبط مرطوب شده و اضافه محلول پس از ۶۰ ثانیه با استفاده از ورق جاذب آب حذف گردید. با استفاده از یک میکروسرنگ، یک قطره عامل اتصال دهنده عاجی Adper Single Bond 2 روی سطح هر نمونه قرار گرفت. پروفایل و زاویه تماس استاتیک قطره با استفاده از دستگاه اندازه گیری زاویه تماس ثبت و بوسیله نرم افزار مرتبط آنالیز گردید. نتایج بدست آمده با استفاده از تستهای One-way ANOVA و Dunnett's t در سطح معناداری مورد ارزیابی قرار گرفتند. ($p<0.05$)

یافته ها: تفاوت آماری بین گروه آب(کنترل) و هیپوکلریت سدیم معنادار بود که به معنای تاثیر منفی هیپوکلریت برانرژی سطحی عاج میباشد ($p=0.013$). تفاوت آماری بین گروه آب و اتانول($p=0.168$) و همچنین گروه آب و کلرهگزیدین($p=0.665$) معنادار نبود.

نتیجه گیری: استفاده از هیپوکلریت سدیم ۵/۲۵٪ حین پروسه شستشوی عاج قبل از باندینگ توصیه نمی شود. شسشتشوی سطح عاج با اتانول ۷۰٪ یا کلرهگزیدین ۰/۲٪ مزیتی در افزایش مرطوب شوندگی سطح عاج نسبت به شستشو با آب نداشته و استفاده از هریک از این محلولها مبتنی بر سایر اثرات کوتاه یا بلندمدت آنها بر فرایند باندینگ می باشد.

واژگان کلیدی: کلرهگزیدین، باندینگ دندانی، اتانول، سدیم هیپوکلریت، رطوبت پذیری

Introduction

Dentin bonding which is the result of permeation of the bonding agent into the inter-fibrillar spaces has an unsatisfactory stability. [1-3] This can be related to the imperfect infiltration of dentin with adhesive. [2] Treating dentin surface may cause adjustments in the properties of dentin which, in turn, may influence the dentin bonding[4] and the surface wettability.[5] High wettability provides close contact between the bonding agent and the surface.[5] The contact angle formed between a drop of liquid and the flat surface of a solid is a good measure of surface wettability and has an inverse relationship with it. [4] Tani et al. suggested that appropriate priming of the dentin surface increases its wettability. [6] It has been observed that ethanol wet-bonding results in better infiltration of the bonding agent [2,3] and the use of cleansing agents on dentin surface alters the water contact angle. [5] Leme et al. also reported that priming of the dentin surface influences the bonding quality. [7] The present study had been designed to evaluate the effect of three priming solutions (70% ethanol, 0.2% chlorhexidine, 5.25% sodium hypochlorite) on the static contact angle of a drop of a bonding agent on the dentin surface and to compare the results with the standard solution (Water).

Materials & Methods

This in vitro study was performed using 20 human premolars debrided of the soft tissue remnants by curetting and immersing in 5.25% NaOCl for 30 minutes. Removing the occlusal third of the crowns with Iso Met saw (Buehler Ltd., Lake Bluff, IL, USA), flat, rigid, non-deformable and highly smooth mid-coronal dentin surfaces were provided.[3,4] To create a

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standardized smear layer, the dentin surfaces were polished with 600-grit silicon carbide paper (Madangoharan Co, Isfahan, Iran). [2] The crown segments were randomly allocated to 4 groups (n=5), according to the priming solutions which were distilled water (Group A), 70% ethanol(Group B), 0.2% chlorhexidine- (Group C) and 5.25% sodium hypochlorite (Group D).

All preparations were etched with 35% phosphoric acid gel (Scotch Etchant, 3M ESPE, St. Paul, MN, USA) for 15 sec, rinsed for 30 sec with tap water and vigorously dried with oil/water-free air. Group A (n=5) was re-hydrated with 10 µL of distilled water, while group B (n=5) was re-hydrated with 10µL of 70% ethanol (Ethanol, Zakaria-Jahrom Ethanol Production Co., Iran), group C (n=5) was re-hydrated with 10µL of 0.2% chlorhexidine solution (Behsa Co., Tehran, Iran) and group D was rehydrated with 10 µL of 5.25% sodium hypochlorite (Whitex, Tehranacid Co., Tehran, Iran). After 60 sec, the excess solution was removed with absorbent paper. [8] A commercially available etch-and-rinse bonding agent (Adper Single Bond 2, 3M ESPE Dental products, MN, USA) was used as the reference liquid to evaluate the contact angle as the wettability index of the dentin. Droplet of the bonding agent was placed on the dentin surface using a micro syringe.

The profile of the droplets was recorded with a video-based optical contact angle measuring system (OCA 15EC, Data physics Instruments, GmbH, Germany) immediately after drop application and analyzed using drop angle analysis software (SCA20, Data physics Instruments, GmbH, Germany) for sessile drop static contact angle measurements (fig.1). The statistical analysis was performed by IBM SPSS statistics 22.0 using One-way ANOVA and Dunnett t tests with the significant level at the p=0.05.

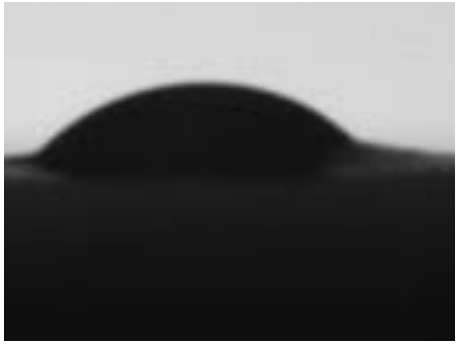

Fig. 1-Sessile drop of bonding agent on the dentin surface

Results

Group B showed the lowest mean static contact angle (22.56), followed by group A (26.52), groups C (28.48) and D (33.19). The mean was significantly different among groups (One way ANOVA, p=0.001). The mean difference of contact angle values between the control group and the test groups is categorized in Table 1. Although there is a statistically significant difference between groups A and D (Dunnett's t, p=0.013), the differences between groups A and B (Dunnett's t, p=0.168) and between groups A and C were not significant (Dunnett's t, p=0.665) (Table 1)

Discussion

The results of this study indicated that the replacement of water with 70% ethanol lead to the lowest contact angle of the bonding agent, but there was no significant difference compared to water. The result is in accordance with the study performed by Li et al., it means that ethanol provides better resin infiltration [2] and enlarges the inter-fibrillar spaces by shrinking the collagen fibrils[3] which, in turn , allow for more resin infiltration into the deep zones of collagen matrix. Considering the results and the facts provided, the replacement of water with 70% ethanol is recommended. The probable increased surface wettability assists full resin penetration through the thickness of demineralized dentin. [2, 8]

It is also evident that 0.2% chlorhexidine which is a Matrix Metalloproteinase (MMPs) inhibitor [8] and not statistically significant may decrease the wettability of dentin surface in comparison to water. Ricci et al. also showed that there was no increase in surface wettability by using chlorhexidine [9] It is concluded that chlorhexidine may only have long-term benefits in preservation of the bond by inhibiting the MMPs and having anti-microbial effect.

In the current study, pretreatment with 5.25% sodium hypochlorite showed significant reduction of the wettability of dentin surface compared to water which was in accordance with a study performed by Dogan Buzoglu et al. on root dentin.[4] As sodium hypochlorite is a proteolytic agent, it removes the collagen fibrils and produces a more hydrophilic dentin surface following application. [10] This means that the hydrophilicity of the bonding agent should be considered in this case. It is recommended to consider the results along with the available limitations. The

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chemical nature and hydrophilicity of the components of the bonding agent used, the concentration of the solutions and the duration and timing of application are the factors that may impact the results.

Table1. Comparison of the mean values with the control group. (Dunnett's t test[a])

Test Groups	Control Group	Mean Difference (Testgroup-Control group)	Std. Error	Sig
B	A	-3.96400	2.04818	0.168
C	A	1.95400	2.04818	0.665
D	A	6.67000*	2.04818	0.013

* The mean difference is significant at the 0.05 level.

a. t-tests treat one group as a control and compare all other groups with it. Dunnett's

Conclusion

Within the limitations of the present study, it is concluded that water as the standard rinsing solution in bonding procedure can be replaced with 70% ethanol or 0.2% chlorhexidine but 5.25% sodium hypochlorite is not recommended.

Conflict of interest: We declare that there is no conflict of interest.

Authors' Contributions

The study was designed by Mehrdad Barekatain and Parvin Mirzakoucheki. The study data were collected by Shahriar Shahriari. Analysis and interpretation of data, drafting of the manuscript, and critical revision of the manuscript for important intellectual content were pre-formed by Mehrdad Barekatain, Parvin Mirzakoucheki and Shahriar Shahriari. Study supervision was performed by Mehrdad Barekatain and Parvin Mirzakoucheki.

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