Atatürk Üniv. Diş Hek. Fak. Derg.
J Dent Fac Atatürk Uni
Cilt:26, Sayı:2, Yıl: 2016, Sayfa: 225-230

Araştırma/ Research Article

ADHESIVE PERFORMANCE OF A RESIN INFILTRANT ON PRIMARY TEETH DENTINE AFFECTED WITH AMELOGENESIS IMPERFECTA≠

REZIN INFILTRANTININ AMELOGENESIS IMPERFECTALI SÜT DIŞI DENTINI ÜZERINDEKI BAĞLANMA PERFORMASININ DEĞERLENDIRILMESI≠

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Makale Kodu/Article code: 2605
Makale Gönderilme tarihi: 08.02.2016
Kabul Tarihi: 15.04.2016

ABSTRACT

Aim: In primary teeth with Amelogenesis Imperfecta (AI) dentine becomes hypermineralised following the loss of enamel which causes for bonding of teeth to get weaker. The purpose is to evaluate the effects of shear-bond strength of ICON material used in AI primary teeth.

Material and Methods: In the study 7 normal and 7 AI affected extracted primary teeth were used. Teeth were sectioned mezio-distally and 14 samples were created for each group. Then teeth were divided in to 2 subgroups of n=7. Group A: ICON (DMG,Germany) was applied to teeth then composite was applied as 1mm increments. Group B: Teeth were treated with total-etch method then composite were applied as 1mm increments. Shear-bond strengths of the samples were measured with Inströn.

Results: In AI primary teeth shear-bond strengths of Icon were found to be lower but not statistically ($p>0,05$). However in normal primary teeth ICON materials shear bond strengths showed statistically lower values ($p<0,05$).

Conclusions: The use of a resin infiltrant Icon to the HCAI affected dentin did not enhance the bond strength values however it might be beneficial if it's used as pre-treatment before application of a conventional adhesive. Further studies on the subject are needed on the subject.

Key Words: Amelogenesis imerfecta, Decidious teeth, dental bonding

ÖZ

Amaç: Amelogenesis imperfectaya(AI) sahip süt dişlerinin hipoplastik minelerinin aşınarak kaybolmasıyla ortaya çıkan dentin dokusunun hipermineralize olması, bu dişlerin dolguyla bağlantılarını zayıflatmaktadır. Çalışmamızda yüzey tabakası hipermineralize olan başlangıç mine çürüklerine uygulanmak için geliştirilen Icon materyalinin, hipermineralize AI'lı dentine bağlanma ajanı olarak uygulanmasının makaslama-bağ dayanımına etkisinin değerlendirilmesi amaçlanmıştır.

Gereç ve Yöntem: Çalışmamızda 7 'şer adet çekilmiş sağlam ve AI'lı süt azı dişi kullanıldı. Dişler mezio-distal olarak ikiye ayrılarak her grup için 14 adet örnek elde edildi. Dişler Sağlam ve AI olarak ikiye ayrıldıktan sonra her ikiside n=7 olarak şekilde alt gruplara ayrıldı. Grup A: Dişlere ICON (DMG, Germany) materyali uygulandıktan sonra 1mmlik tabakalar halinde kompozit uygulandı. Grup B: Dişlere total etch yöntemi ile asit ve bonding işlemleri uygulandıktan sonra 1 mmlik tabakalar halinde kompozit uygulandı. Elde edilen örneklerin makaslama bağ dayanımı değerleri Instron aletiyle ölçüldü.

Bulgular: AI'lı süt dişlerinde ICON uygulanmasının makaslama-bağ-dayanımı değerlerinin istatistiksel olarak anlamlı olmamakla beraber daha düşük olduğu gözlendi ($p>0,05$). Sağlam süt dişlerinde ise makaslama-bağ-dayanımı değerleri ICON bonding ajan olarak uygulandığında istatistiksel olarak düşük bulunmuştur ($p<0,05$).

Sonuç: AI'lı dentinde ICON materyalinin bağlanma ajanı olarak kullanmasının makaslama-bağ-dayanımı değerlerini artırmamıştır, ancak geleneksel bonding ajanı öncesinde uygulanmasının faydalı olabileceği düşünülmektedir. Konu ile ilgili detaylı çalışmaların yapılması gerektiğini düşünmekteyiz.

Anahtar Kelimeler: Amelogenesis imperfecta, süt dişi, diş yapıştırma

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≠Bu çalışma 19. Türk Pedodonti Derneği Kongresi 04-07 Ekim 2012 Antalya'da poster sunumu olarak takdim edilmiştir.

INTRODUCTION

Amelogenesis imperfecta (AI) is a group of hereditary developmental disorder that affects the deposition, mineralization and maturation of the enamel of some or all teeth in the primary and/or permanent dentition[1-3]. The clinical appearance of enamel defects shows large variety, ranging from structure deficiencies to mineral and protein content defects[1].

Clinical management of AI especially in young children is a complex set of treatments that usually aims to improve aesthetics and function of the teeth using bonded restorations[2]. In some cases the bonded restorations are successfully used however in many other patients, adhesive restorations show high failure rates[4,5].

Enamel of patients with hypocalcified amelogenesis imperfecta (HCAI) has a lower mineral content and thus is more porous and easily chips away, loss of enamel becomes apparent[6].

Sanchez-Quevedo et al.[7] showed that HCAI affected dentine responses to the enamel disorders by showing high calcium levels. HCAI affected dentine shows morphologic pattern that's similar to the sclerotic dentine in form of hypermineralization. Sclerotic dentine's high mineral content causes low bond values due the compromise in the formation of the hybrid layer[8,9].

Saroglu et al.[10] reported that deproteinization using sodium hypochlorite is an effective treatment in enhancing the enamel bonding in hypocalcified AI enamel, however no enhancing effect was seen on AI dentine.

Resin infiltration system Icon (DMG, Germany) was specially developed for removing the highly mineralized surface of initial caries lesions. Initial caries lesions are also known to have high mineral content, due to that it has been shown that adhesive penetration following two minutes of phosphoric acid application is superficial[11,12]. 60sec application of sodium hypochlorite thought to be promising method for deproteinization of initial caries lesions which is similar method that's used in AI as well[13]. Studies investigating a better penetration for initial caries lesions lead to the development of Icon (DMG, Germany) product which is a resin material that is applied following the 120 sec Hydrochloric acid (HCl) etching and ethanol rinsing[14]. Studies showed that 120 sec application of HCl removes the high mineral concentrated layer of enamel lesions and hence enhances the resin penetration both in primary and permanent teeth[12,15,16].

Since HCAI affected dentin is also highly mineralized like initial caries lesions, we hypothesize that resin infiltration system Icon would remove the mineralized surface layer and penetrate deeply in the HCAI affected dentine hence improve the shear bond strength values when used as a bonding agent.

The purpose of this study was to evaluate the effect of Icon resin infiltration material used as a bonding agent on dentin of the primary teeth affected with HCAI on the shear bond strength of adhesive system.

MATERIAL AND METHOD

Specimen preparation:

Seven primary molars were collected from boy and girl siblings aged 10 and 11 years, with HCAI. The diagnosis of HCAI was done by clinical examination and the criteria described by Witkop[17]. It has been noted that large areas of dentine with yellowish-brown discoloration was exposed and most of the enamel had been chipped away or worn off. Comparable seven non-carious teeth collected from apparently healthy 10-11 year old children served as control. The teeth used in this study were in time of exfoliation and collected after the patients' informed consent was obtained. The extracted teeth were stored in deionized water and were used within 1 month following extraction.

Normal and HCAI effect teeth were divided into two mesiodistally, following that the enamel layer of normal teeth were removed. A flat surface of 3 mm in diameter was prepared on the buccal and lingual dentin surfaces of all teeth by moist grinding on 200–400 and 600-grit silicon carbide paper.

Bonding procedures:

The teeth with HCAI and the normal teeth were divided into two groups (n=7) depending on the bonding type.

Group 1 (control group): Dentin surfaces of HCAI and sound primary teeth were etched for 20 sec with 36% phosphoric acid (Dentslpy, De Trey, York, PA, USA), then rinsed with water for 15 s and gently

air dried for 1–2 s. A two-step etch-and-rinse adhesive, Prime & Bond® NT™ (Dentsply De Trey, York, PA, USA), was applied to the dentine surfaces, air-dried, and light-cured for 40 s using a quartz-tungsten-halogen light-curing unit (Demetron LC, Kerr, Orange, CA, USA) operated at 600 mW/cm.

Group 2 (Icon group): Dentin surfaces of HCAI and sound primary teeth were etched for 120s with %10 HCl (Icon etch, DMG, Hamburg, Germany), then rinsed with water for 30s and gently air dries for 1-2 s. Following that the teeth is rinsed with Icon Dry (Icon, DMG, Hamburg, Germany) for 30c and then gently air dried for 1-2 s. Icon resin (DMG, Hamburg, Germany) was applied for 3 minutes and light-cured for 40 s using a quartz-tungsten-halogen light-curing unit (Demetron LC, Kerr, Orange, CA, USA) operated at 600 mW/cm.

For both groups resin composite build-ups were performed on the bonded specimens using a light-cured microhybrid composite (Filtek Z250, 3M ESPE, St Paul, MN, USA) in five 1-mm increments that were light-activated separately.

Shear bond strength testing:

After storage in distilled water at 37 °C for 24 h, Shear bond strength was measured in a Shear bond strength was measured in Instron Universal Testing Machine (Instron; Norwood, MA, USA). A parallel knife-edge shearing device was aligned 0.05 mm from the bonded interface and force was applied to failure using a crosshead speed of 1 mm min^{-1}.

Statistical Analysis:

Sample size was calculated on the basis of data from a previous study[10] on the shear bond strengths of HCAI with $\alpha = 0.05$ and $1-\beta = 0.8$, we calculated that n=7 for each group would be needed to find significant differences. The data were analysed using Mann-Whitney U test to evaluate differences among groups ($p < 0.05$).

RESULTS

The mean shear bond strengths for all groups are shown in Table 1.

Bond strength to HCAI dentin (15.6 MPa) and the normal teeth dentin (19.2 MPa) showed no statistical difference ($p > 0.05$) in the control groups however bonding to the normal teeth showed numerical difference.

A statistically significant difference at $p < 0.05$ level was detected when Icon was applied as a bonding agent between HCAI (12.8 MPa) and the sound primary teeth (16.1 MPa).

However, when the dentin shear bond strengths of the control and treatment groups were compared in normal teeth, significantly lower bond strengths were found in the Icon group ($P < 0.05$).

There was no statistical difference in the bond strengths of HCAI dentin between Icon group (12.8 MPa) and control group (15.6 MPa) ($p > 0.05$).

Table 1. Mean shear bond strengths of control and Icon treated dentin surfaces (MPa)

Treatment groups	***HCAI***	***Sound Primary Teeth***
CONTROL	$15.6 \pm 3.8^{a,A}$	$19.2 \pm 2.0^{b,A}$
ICON	$12.8 \pm 1.4^{a,B}$	$16.1 \pm 1.6^{c,C}$

Groups identified by different lowercase superscript letters shows significant difference between columns and different uppercase superscript letters show significant difference between lines different at $P < 0.05$. n= 7 in all groups.

DISCUSSION

Generally prosthetic restorations are preferred for adult population however [18,19,20], it is not a good option for children due to ongoing growth so adhesive restorations are preferred. Minor defects of HCAI effected tooth can be successfully treated with adhesive restorations in children, however if most enamel is lost adhesive restorations are not as successful[4, 5, 21]. The reasons of failure are generally considered as the morphological and chemical differences between sound and AI teeth[22,23].

There have been several methods investigated for enhancing the enamel and dentin bonding of HCAI teeth. Hiraishi et al.[24] investigated the effect of extended etching time on the bond strength of AI effected teeth. Their results showed that bonding to the AI affected dentin could not be improved by extended etching time. Use of NaOCl has been shown to improve the bonding of HCAI enamel by several reports[10,25,26]. However, no improving effect of NaOCl has been observed when it's used in HCAI dentin[10]. Sanchez-Quevedo et al.[7] showed that HCAI affected

dentine shows morphologic pattern similar to the sclerotic dentin which is characterized by thickening of the peritubular dentin and partial obliteration of the dentin tubules and hypermineralization. Tubule occlusion by mineral salts, preventing resin tag formation in sclerotic dentin is thought to be the reason why sclerotic dentin shows lower bond strength compared to the normal dentin[9]. This phenomenon is thought to be the explanation for the lower bond strengths in HCAI dentin compared to normal dentin[10].

Bergman and Lind[27] reported that natural initial caries lesions are highly mineralized and shows mineral content of 83% in the surface layer. It has been shown that if the initial caries lesions are pre-treated with phosphoric acid, adhesive penetration usually happens only superficially[11]. The low penetration values are explained by the highly mineralized surface layer of initial caries lesions, which inhibits the capillary penetration of the resin to deeper layers[11,12]. It has been showed that 2 min %15 HCl is more effective than 2 min 37% H_3PO_4 in eroding the highly mineralized surface layer of enamel lesion both in primary and permanent teeth[28,29]. However the studies showed that even with the etching using %15 HCl for 2 min commercially available adhesives shows superficial penetration[11,12]. Thus a new low viscosity light curing material called as infiltrant is developed and manufactured with 15% HCl etch as resin infiltrant Icon (DMG, Germany) system[14]. Studies showed that 3 min application of the infiltrant flowing 2 min etch with 15%HCl penetrates better in the highly mineralized surface layer of initial caries lesions both in primary and permanent teeth[25,26].

In the study we investigated if the use of Icon infiltrant could improve the adhesion of resin composite to HCAI affected dentin. Results showed that bonding with Icon did not had an enhancing effect furthermore the bond strength values with Icon bonding were lower compared to standard bonding procedures. Wiegand et al.[30] used the Icon as a bonding agent alone and as a pre-treatment before 35% phosphoric acid followed by a conventional adhesive, their results showed that the combination of resin infiltrant and conventional adhesive showed significantly higher shear bond strength values than the conventional adhesive alone however the Icon application alone didn't show any difference from the other groups in initial caries lesions. Chay et al.[31] investigate the effect of Icon used as a bonding agent in hypomineralised teeth which are also known for low bonding strengths values. Their results showed that the use of resin infiltration alone as bonding decreased micro shear bonding values and also resulted in significantly lower micro shear bonding compared to normal enamel this results are in-line with our study[31]. Although our study investigated the effect in HCAI teeth, the results showed that the bonding strength decreased when Icon was used as bonding in HCAI teeth dentin and shear bond strength of normal teeth were greater compared to HCAI when resin infiltrant Icon is used as a bonding agent.

Shear bond strength values of 17-24 MPa is generally accepted as the required value for composite resin to resist polymerization contraction forces[32,33]. Although Icon applied normal teeth showed higher values than HCAI affected teeth, our results showed lower values than 17 MPa for all Icon applied groups. Also the bond strength values for both groups in HCAI affected dentin showed lower values than 17 MPa. Costenoble et al.[34] investigated the effect of Icon pre-treatment before orthodontic bracket bonding for eroded teeth and showed that resin infiltration for eroded teeth showed no significant differences in bond strength values compared to sound teeth. However their study also showed that if bonding was delayed following the pre-treatment the bonding values were lower for Icon application where the bonding strength value was also slightly lower than of 17 MPa (16.6 MPa).

Our hypothesis that application of resin infiltration system as a bonding system for HCAI affected dentin would enhance the bonding values was rejected. At present it's still unclear which method would increase the shear bond strength values of HCAI affected dentin. It would be useful to investigate further effects of resin infiltration use combined with conventional adhesives and NaOCl.

CONCLUSION

The use of a resin infiltrant Icon to the HCAI affected dentin did not enhance the bond strength values however it might be beneficial if it's used as pre-treatment before application of a conventional adhesive. Further studies on the subject are needed to

find methods to enhance bonding to these morphologically altered tooth structures.

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