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SHEAR BOND STRENGTH OF PREVENEERED POSTERIOR STAINLESS STEEL CROWNS

ÖNCEDEN VENEERE EDİLMİŞ ARKA GRUP PASLANMAZ ÇELİK KURONLARIN KESME BAĞLANMA GÜÇLERİ

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ABSTRACT

Purpose: *The purpose of this study was to evaluate the shear bond strength of veneer material of posterior preveneered stainless steel crowns (SSCs).*

Methods: *32 preveneered SSCs (lower first primary molar=8, upper first primary molar=8, lower second primary molar=8 and upper second primary molar=8) were used for this study. Specimens were kept in humid environment at 37^{0}C for thirty days and exposed to thermocycling. Then, each veneered crown was cemented on one of the cast dies. After twenty-four hours, force was applied on the occlusal surfaces of the crowns according to primary molar occlusal relationship. The fractured specimens were photographed under X10 magnification with a stereomicroscope. Characterizations of the failure modes and fracture extents of the veneer material were scored. Data were analyzed statistically.*

Results: *For bond strength, there was a statistically difference between crown groups (P<0.05). However, there were no significant differences between both failure modes and fracture extents of the crown groups (P>0.05).*

Conclusions: *This study showed shear bond strength, failure modes and fracture extents of the preformed posterior esthetic crowns.*

Key words: *Preformed crowns, esthetic crowns, stainless steel crowns.*

ÖZET

Amaç: *Bu çalışmanın amacı, önceden veneere edilmiş arka grup paslanmaz çelik kuronların (PÇK) veneer materyalinin kesme bağlanma gücünü değerlendirmektir.*

Yöntemler: *Bu çalışmada 32 adet önceden veneere edilmiş PÇK (alt 1. süt azı=8, üst 1. süt azı=8, alt 2. süt azı=8 ve üst 2. süt azı=8) kullanılmıştır. Örnekler 30 gün boyunca 37^{0}C'de nemli ortamda tutulmuş ve termal siklus işlemine tabi tutulmuşlardır. Daha sonra, her bir veneere edilmiş kuron metal güdüklere simante edilmiştir. 24 saat sonra, süt azı okluzal ilişkisine göre kuronların okluzal yüzlerine kuvvet uygulanmıştır. Kırılmış olan örnekler steromikroskop ile 10X büyütme altında fotoğraflanmıştır. Veneer materyallerinin başarısızlık tipleri ve kırık yaygınlıkları skorlanmıştır. Veriler istatistiksel olarak analiz edilmiştir.*

Bulgular: *Bağlanma gücü için, kuron grupları arasında istatistiksel olarak anlamlı farklılık bulunmuştur (P<0,05). Bununla beraber, kuron gruplarının hem başarısızlık tipleri hem de kırık yaygınlıkları arasında anlamlı farklılık bulunmamıştır (P>0,05).*

Sonuçlar: *Bu çalışma, önceden veneere edilmiş arka grup estetik kuronların kesme bağlanma gücünü, başarısızlık tiplerini ve kırık yaygınlıklarını ortaya koymuştur.*

Anahtar kelimeler: *Hazır kuronlar, estetik kuronlar, paslanmaz çelik kuronlar*

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INTRODUCTION

Preformed stainless steel crowns have been used widely for extensive caries and pediatric endodontic treatment for 55 years because of being easily placed, good durability and low cost[1]. However, they have a metallic gray appearance which may cause dissatisfaction of children or parents. Thus, to overcome this problem, several authors have been suggested open-faced SSCs or chairside veneering SSCs[2-8]. In addition, in the mid-1990, pre-veneered SSCs, were developed and marketed for both anterior and posterior primary teeth restorations. Although many studies have been conducted at both in vitro and in vivo conditions using anterior preveneered SSCs, studies conducted using posterior pre-veneered SSCs are limited[9-14]. Some researchers reported that both anterior and posterior pre-veneered SSCs showed chipping of the facing depending on the long-term clinical performance[15,16]. However, there have been no studies to evaluate shear bond strength of veneer material for the posterior preveneered SSCs.

The aim of this study was to evaluate the shear bond strength of veneer material of posterior preveneered SSCs.

MATERIALS AND METHODS

A total number of 32 preveneered SSCs (NuSmile Primary Posterior Crowns, NuSmile Crowns a Division of O.T., Inc. 5524 Cornish, Houston Texas) (lower first primary molar=8, upper first primary molar=8, lower second primary molar=8 and upper second primary molar=8) were used for this study. Upper and lower first primary molar crowns and upper and lower second primary molar crowns were having the same size. In this study, NuSmile posterior crowns were used, because they are widely used and marketed. After an impression of the internal surface of the each crown was obtained using an impression material, wax patterns were prepared. Then, 32 cast dies were fabricated with chromium cobalt metal. Meanwhile, impressions were made from conventional SSCs in similar sizes to preveneered SSCs to be tested and also specific waxups were prepared. Thus, the cast dies to be used for loading were fabricated using chromium cobalt metal.

Veneer material of NuSmile posterior crown is a hybrid composite resin.[11]. Fatigue tests of composite resins were run in a humid condition, where composites are soaked in water for at least 30 days[17]. Thus, specimens were kept in humid environment (artificial saliva)[18] at 37^0C for thirty days and exposed to thermocycling 500 times at a range of 4°C to 55°C. Then, each veneered crown was cemented onto one of the cast dies with temporary luting cement (Life Regular Set, Kerr, Orange, U.S.A.) mixed to the manufacturer's specification.

After twenty-four hours following the cementation, each die was placed into a mechanical testing machine and loaded with a force applied by a mechanical testing machine (Hounsfield, Test Equipment, 37 Fullerton Road Raydon/England) to obtain fracture force value.

Chromium cobalt cast loading dies with a crosshead speed of 1.5 mm/minute were used to load on occlusal surfaces of the specimens. Loading procedure was done according to primary molar occlusal ship to simulate oral forces[19]. The loading was continued until failure of the veneer material. The data were recorded in Newtons (N). The fractured specimens were photographed under X10 magnification with a stereomicroscope (Nicon SMZ-U multi-point-sensor system, Japan). Characterizations of the bond failure of the veneer material were scored as adhesive failure (at the steel/resin interface), cohesive failure (within the facing material), or adhesive/cohesive failure (mixed)[20]. In addition, the characterizations of the fracture extents of the veneer material were; no loss but cracking, loss of a third (1/3), loss of one second (1/2) and loss of complete (1/1)[21].

Bonding forces obtained from the veneer materials of each crown group were analyzed with one-way ANOVA and Tukey's HSD test. Failure types and fracture extents of the veneer material of the tooth groups were compared with Kruskal-Wallis test. For all statistical analysis, significance level was set at $P<0.05$.

RESULTS

The mean values for the forces required to dislodge veneer material are given in Table 1. In order to determine whether there was a significant difference between shear bond strength values from the crown groups, one-way ANOVA analysis was applied, with the result that there was a difference between the groups ($P<0.05$). To understand the source of this difference, Tukey HSD test was applied. The results are given in Table 1.

Failure types and fracture extents are summarized in Table 2. When both failure types and

fracture extents were compared using Kruskal-Wallis test, there were no significant differences between crown groups (P>0.05). The fractures that occurred at veneer material of each crown group were characterized either cohesive or mixed failures (Figs. 1 and 2). Specimens showed cracking, loss of a third or one second fracture extends (Figs. 1, 2, 3 and 4). None of the specimens had loss of complete at fracture extent. In addition, dislodged veneer material was observed by a spalling (Fig. 3).

Table 1. The mean fracture forces of the veneer material of crown groups

Groups	N	Mean Values (N)	±SD
Lower first primary molar[a]	8	663	242.7
Upper first primary molar[a]	8	925	375.6
Lower second primary molar[b]	8	1718	172
Upper second primary molar[c]	8	1331	247.7

The difference between the groups marked by the same letter is statistically insignificant (p>0.05)

Table 2. Failure types and fracture extents at the veneer material of crown groups

Tooth Groups	Failure Type				Fracture Extent			
	N	*dhesive*	**Cohesive**	**Mixed**	**Cracking**	***1/3***	***1/2***	***1/1***
Lower first primary molar	8	0	0	8	0	7	1	0
Upper first primary molar	8	0	1	7	1	6	1	0
Lower second primary molar	8	0	1	7	1	6	1	0
Upper second primary molar	8	0	3	5	3	4	1	0

Figure 1. Cohesive failure, cracking in the veneer material of upper second primary molar (Original magnification X10)

Figure 2. Mixed failure, spalling, loss of a third of the veneer material of upper second primary molar (Original magnification X10)

Figure 3. Mixed failure, loss of one second of the veneer material of lower first molar (Original magnification X10)

Figure 4. Mixed failure, loss of a third of the veneer material of lower first molar (Original magnification X10)

DISCUSSION

Although preveneered SSCs provide excellent esthetics at the placement time, local overload causes chipping or fracturing of the crowns[15,16] . It has been reported that chipping or fracturing of the esthetic materials of the crowns are remarkably frequent[15,16].

NuSmile crowns' veneer material is a hybride resin composite. In the study, before testing, specimens were aged for 30 days in artificial saliva[17,18]. The average forces required to dislodge of veneer materials ranged from 663 N to 1718 N (Table 1). These values had a fracture resistance greater than the average biting force of 5- to 10-year old children (375.N) [22]. However, in the time, veneer fractures may be occurred in the mouth[15,16]. Ram et al.[15] stated that all NuSmile posterior crowns were presented chipping at the end of the 4 years. Shah et al.[16] concluded that resin facings were completely lost in %13 of the anterior esthetic crowns after 17.5 months.

There was significant difference between the primary first and second molars ($P<0.05$) (Table 1). Surprisingly, upper and lower primary second crowns were significantly different at $P<0.05$, but not upper and lower primary first crowns ($P<0.05$) (Table 1).

In this study, failure types of veneer material were cohesive or mixed failure (adhesive/cohesive) (Table 2; Figs. 1 and 2). None of them showed adhesive failure. The probable cause of why adhesive failure was not observed can be due to the fact that the veneer material was bonded to stainless steel base using the sandblasting method. In addition, separation from stainless steel base of veneer material was characterized by a spalling (Fig. 3). These results were agreed with failure modes observed in the previous studies which were used preformed NuSmile crowns[9,10,20,21]. Perhaps the observed failure types might be due to the fact that veneer material was bonded to stainless steel base using the sandblasting method. Moreover, the extents of fracture of veneer material in the study were cracking, loss of a third or loss of one second of the veneer. These findings are in agreement with that of previous study, in which NuSmile primary anterior crowns were tested[21].

CONCLUSIONS

1. *Veneer material in all of the crown groups had a fracture resistance greater than the average biting force of 5-to10- year old children.*
2. *Both lower and upper second molar crown groups showed higher shear bond strengths than first primary molar crown groups.*
3. *Veneer material was observed a common mixed fracture type and 1/3 fracture extend.*
4. *Separation from stainless steel base of veneer material was characterized by a spalling.*

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