

EXAMINATION OF BOND STRENGTH OF RESIN TEETH TO DENTURE RESINS*

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ÖZET

Farklı marka akrilik dişlere farklı restoratif materyallerin bağlanma kuvvetlerini incelemek ve monomer uygulamanın etkisini değerlendirmek amacı ile bu çalışma yapıldı.

Bu amaçla, kliniğimizde rutin olarak kullanılan iki ayrı firmaya ait iki farklı akrilik rezin santral diş ve restorasyon için üç farklı protez rezin materyali (ısı ile polimerize akrilik, otopolimerizan akrilik ve ışıkla polimerize kompozit rezin) kullanıldı. Toplam 60 santral dişin yarısına (her grupta eşit sayıda olacak şekilde) monomer uygulandı, diğer yarısına uygulanmadı. Dişlerin bir kısmına (5 monomerli, 5 monomersiz diş) otopolimerizan akrilik, bir kısmına ısı ile polimerize akrilik ve bir kısmına da ışıkla sertleşen kompozit uygulandı. Daha sonra bağlanma kuvvetini tespit edebilmek için Haunsfield çekme- sıkıştırma cihazında 130o açı ile kuvvet uygulandı.

Elde edilen veriler varyans analizi ile değerlendirildi. Kullanılan tamir materyalinin ve monomer uygulamanın çok önemli ($p<0.001$), farklı diş grubunun ise önemli ($p< 0.05$) olduğu istatistiksel olarak saptandı. Bağlanma direncinin en fazla ısı ile sertleşen akrilik rezinde en az ışıkla sertleşen kompozitte olduğu görüldü).

Anahtar Kelimeler: Akrilik rezin dişler, tamir materyali, bağlanma kuvveti.

ABSTRACT

This study was carried out with the aim of examining bond strength of belonging to different productive firms acrylic teeth and different denture resins and it was also carried out with the purpose of evaluating the effect of monomer application.

For this purpose, two different acrylic resin central teeth depending to different firms were two used routinely in our clinic, and three different denture resin materials used in restoration (heat- cured, light- cured and autopolymerizing acrylic resins) were used. Monomer was applied to the half of total 60 central teeth, in equal number from both groups and it wasn't applied to the other half. 30 teeth to which monomer was applied, and 30 teeth to which monomer was not applied were divided into three groups equally.

Autopolymerized acrylic with 5 monomers and without 5 monomers was applied to some of teeth, and heat cured acrylic was applied to some of teeth, and light-cured composite was applied to some of teeth by divided them into three groups; and breaking off-force was applied with 130o angle in Hounsfield-pulling and pressing equipment.

The values obtained were evaluated with variance analysis. It was concluded that the type of repairing material used was statistically significant ($p<0.001$).

It was observed that bond strength was the highest in heat-cured acrylic and it was the least in light-cured composite. It was seen that the most bonding resistance was in the group applied to monomer in two groups and these two group teeth showed different bonding strength.

Key Words: Acrylic resin teeth, repairing materials, bond strength

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INTRODUCTION

Artificial teeth in an acrylic structure are often used to function on denture base materials. The most important of these teeth is their chemical bonding to denture base materials.¹⁻⁴

The combination of acrylic teeth, as in the case of denture base acrylic, is polymethylmethacrylate copolymerised with cross bonding substance. To reduce fracture in acrylic teeth, a higher proportion of cross bonding substance is used. To ensure chemical bonding with denture base material, polymethylmethacrylate (PMMA) is not used in higher proportion in gingival ridgelap areas than that in incisal areas.^{1,5,6} Urethan dimethacrylate teeth with micro-filler have been developed so that durability against wearing can be increased.⁶

Although indicated that there is a well chemical bonding, separation of the acrylic teeth from the denture base can be frequently seen. Rather than the fracture of the teeth due to tension, a rupture in the in the surface of teeth-denture bonding occurs. It is indicated that this repture may be due to failure in removing the wax traces remaining on the ridgelaps or to careless application of separating medium.^{2,3}

Cunningham,⁷ in his study carried out in 1993, stated that more than %80 of dentures were repaired, and that one third of these repaires were composed of the debonding of the teeth in anterior site.

The most frequently used repairment material is autopolymerised acrylic resin because of its easy application and being prepared in a short time. Heat-polymerised

acrylic resin usage requires a longer period of processing though providing a higher accommodation with denture material.⁸⁻¹¹

Recently, composite resins have been used in the repair of fractured or lost denture teeth due to quick and easy polymerisation of these resins.¹²

Recently, visible light- cure resin has become increasingly popular as an alternative to heat- cured or autopolymerizing acrylic resins for many prosthodontic applications.

The purpose of this study was to investigate the bonding strength of belonging to two different firms brands of acrylic teeth and different repair materials and to evaluate the effect of monomer application on this strength.

MATERIALS AND METHODS

In this study, two different brands of acrylic teeth (Akryldent; Ak Plastik Diş Sanayi, İstanbul-Turkey, Majordent; Prodotti Dentari, Moncalieri, Italy) and three different repair materials (heat-polymerised acrylic; QC 20 De Trey, England, auto-polymerised acrylic; QC 20 De Trey, England, light-polymerised composite resin, Valux Plus, 3M dental products, USA) were used. The reason for the using of the teeth in two different structure belonging to different firms, that is acrylic resin structure, is to detect whether they indicate difference as regards bonding strenght to repair materials even if the teeth have same structure .

In the teeth choice, special care was taken to use the same dimension of teeth. In separated into pieces narrowing towards colulum dentis, with the dimensions of 8.5 mm.

in diameter and 15 mm. In height, it was used in order to simulate the bonding denture order to prepare autopolymerised and heat-base plate on. The teeth were inserted into base material with base plaque wax. In polymerised samples, it was loaded into the mould and the teeth were placed on the ground simulating collum dentis. Flasking was performed by means of known methods. To remove the wax traces, flasks were immersed in boiling water for 5 minutes, and then were washed 3 times with pressured boiling water containing detergent and rinsed with clean boiling water. Paying utter attention to the isolation process of plaster in flask were divided into two groups. No operation was performed on the first group (20 teeth). Acrylic monomer was applied to the teeth in the second group for 3 minutes. Specimen flasks in equal numbers from each group (20 Majordent, 20 Acryldent) were chosen and sohe of them (10 monomer applied, 10 not applied) were loaded with heat-polymerised acrylic resin, and the rest (10 monomer applied, 10 not applied) with autopolymerised acrylic (Table 1). Polymerisation procedure was applied according to the recommendations of the manufacturers. Excess acrylic on the specimens removed from the flask was remove. Monomer was applied on the part that repair material would be placed (part adhering to denture base plate) to the 10 of the rest 20 central teeth (10 Majordent, 10 Acryldent) for 3 minutes. No procedure was performed on the rest half. The light polymerisation was performed by opening the pieces of mould after the teeth were placed on the part simulating the collum dentis subsequent to the placement of the light-poly-

merised composite directly into the mould. In order to achieve a full polymerisation, light cure was applied from 4 different sites for 20 seconds (Fig. 1).

Table 1. Samples groups.

	<i>Acryldent</i>		<i>Majordent</i>	
	With Monomer	Without Monomer	With Monomer	Without Monomer
Heat-polymerised acrylic resin	N	N	N	N
Auto polymerised acrylic resin	5	5	5	5
Composite resin	5	5	5	5

To measure the bonding strength, Hounsfield testing machine was used. Force was applied with a stainless steel pin in 1 mm. diameter, having 130°C angle with the long axis of teeth and with a speed of 5 mm/min until the failure occurs. This angle was chosen to simulate the mean angle occurring with the contact between upper and lower jaw teeth in class I occlusion.

Analysis of variance was used in comparing the values obtained. Mean and standard deviation values were calculated. A multicomparison test was also performed.¹³

RESULTS

The results analysis of variance used in the evaluation of bonding between plastic teeth and repair materials are shown in Table 2.

As it can be seen from the table, the type of the repair material used ($p<0.001$), the brand used ($p<0.05$), the procedure carried out ($p<0.001$) and the mutual interactions are statistically significant.

The distribution of bonding strength values obtained and LSD (Least Significant Difference) test result are shown in Table 3.

As a result of multi-comparison test, it was determined that every three materials, different brands of teeth and the groups with monomer or without monomer showed different bonding from each other statistically.

When the means belonging to twenty observations were evaluated; it was seen that the best bonding is achieved in the heat-polymerised acrylic (314.25 N), the autopolymerised acrylic followed this (161.60 N), and that the least bonding strength is seen in the

light polymerised composite (42.50 N) (Table 4).

In teeth groups in which monomer application was made, besides much more bonding strength was detected in both brand teeth (akryldent; monomerli: 178.33 N, without monomer 145.47 N, majordent ; with monomer :215.33 N without monomer 152.00 N) it was seen that the most bonding strength occurred in Majordent brand teeth (215 N) (Table 5). An increase was detected in bonding strength of repair materials to which monomer was applied. .

Table 2. Variance analysis of the bonding values of plastic teeth and repair materials.

Source of variation	df	Sum of squares	Mean squares	F value	
Various Brand of Teeth (VBT)	1	7106.817	7106.817	5.651	P<0.05
Repair Material (RM)	2	742232.63	371116.32	295.087	P<0.001
With Mon-Without Mon	1	34704.150	34704.150	27.594	P<0.001
VBT x RM	2	7715.633	3857.817	3.067	P<0.1
VBT x MM	1	3480.817	3480.817	2.768	P<0.05
RM x MM	2	8518.300	4259.150	3.387	P<0.05
VBTxRMxMM	2	17856.633	8928.317	7.099	P<0.01
Error	48	60367.200	1257.650		

VBT: Various Brand of Teeth

RM: Material Repair

Mon: Monomer

MM: Thegroup applied and not applied monomer

Table 3. The table indicating average and standart deviation values of test results belonging to monomer application and teeth groups and repair materials(n=5) (X=N).

	Acryldent				Majordent			
	With Monomer		Without Monomer		With Monomer		Without Monomer	
	X*	SD	X*	SD	X*	SD	X*	SD
Heat-polymerised acrylic resin	330.00 ^a	18.71	282.00 ^a	37.68	330.00 ^a	23.45	315.00 ^a	29.58
Auto polymerised acrylic resin	145.00 ^b	28.78	126.40 ^b	32.66	260.00 ^b	47.43	115.00 ^b	39.05
Composite resin	60.00 ^c	12.25	28.00 ^c	8.37	56.00 ^c	15.17	26.00 ^c	8.94

* : The distinction between averages shown by different letters in a main factor stically significant (a,b,c; p< 0.05 is statistically significant).

Table 4. The table indicating generalbonding strenght of repair materials.

	X*	SD
Heat-polymerised acrylic resin	314.25 ^a	7.93
Auto polymerised acrylic resin	161.60 ^b	7.93
Composite resin	42.50 ^c	7.93

* : The distinction between averages shown by different letters in a main factor stically significant (a,b,c; p< 0.05 is statistically significant).

Table 5. The table indicating the groups applied or not applied Monomer (X= N).

Acryldent				Majordent			
With Monomer		Without Monomer		With Monomer		Without Monomer	
X	SD	X	SD	X	SD	X	SD
178.33	25.00	145.47	11.56	215.33	23.86	152.00	27.90

DISCUSSION

The bonding of the tooth to the denture base depends on a lot of factors. These may include polymerization cycles, repair materials, physical modifications of the teeth sur-

faces, laboratory procedures and the wetting of the teeth surfaces with suitable agents like monomer liquid.^{7,14,15}

As a result of the studies carried out, it was seen that the heat-polymerised and auto-polymerised acrylic resins make a better bonding that of the acrylic resins hardened by visible lights.^{4,16-22}

Yanikoglu et al.,²⁰ pointed out that the strongest bonding to acrylic resin teeth is achieved in the heat-polymerized acrylic, and the weakest is in the light polymerized composite.

Shen et al.²³ stated that the bonding between acrylic resin teeth and composite is not very satisfactory due to their chemical composition differences. Cook et al.²⁴ found out that as reactive methacrylate groups of molecules are similar, the polymerisation process of MMA (methyl methacrylate) and BIS GMA (bisfenol A glisidyl methacrylate) followed similar patterns and stated that starting from this point, some acrylic bonding between acrylic resin teeth and composites. Visible light cured composites were proved to be non-toxic and biocompatibly.²⁵ The preference reasons of these materials having a

widespread usage in prosthodontic applications are higher wearing resistance, polymerisation without leaving excess products, manufacture and usage facility, patients satisfaction, bonding peculiarity with the other denture resins and low bacterial affinity. Because of facilities and advantages, it seems that the light cured composites are suitable in short-term prosthetic applications.¹⁷

In this study, it was determined that the greatest bonding is seen in the heat-polymerised acrylic (314.25 N), autopolymerised acrylic followed it (161.60 N), and that the least bonding strength is achieved in light cured composites (42.50 N). This result is compatible with those of the above mentioned researchers.

In denture repair, the surfaces are prepared as desired, cleaned and monomer applied to the surface before placing the repair materials. Correct surface preparation means a strong bonding. It was shown in previous studies that the exposure time of MMA monomer caused a great variety of changes in increasing the bonding of other polymer materials to acrylic resin surfaces.⁹ Chung et al.²⁶ and Shen et al.²³ applied monomer for 5 and 15 second. Kawara et al.¹⁹ applied monomer for 1 minute. Huggett et al.²⁷ and Ogle et al.²⁵ made tests by monomer for various periods. Vallittu et al.²⁸ emphasized that a three minute wetting time with MMA monomer is necessary in order to form a strong bond.

In our study, the surfaces of the teeth were wetted with MMA monomer for 3 minutes in accommodation with the ideas of Vallittu et al.²⁸

Spratley,⁴ stated that the wetting the teeth surfaces in contact with denture with monomer-polymer mixture did not increase the adhesion. Although some researchers claimed that wetting with monomer the site that acrylic resin teeth contacting with the denture did not affect the strength,^{2,27,29} Geerts and Jooste¹⁴ determined in their study that the bonding increased.

In our study, it was determined that there was an increase in the bond strength statistically in the teeth group to which monomer-polymer solution was applied. This result is in accommodation with the findings of Geertz and Jooste,¹⁴ but not with those of the other researchers when monomer was applied to.

Sorenson and Fjeldstat³⁰ tried to increase the bonding by wetting the contacting surfaces of teeth with denture and by the resolution of the monomer discs at this site, and determined that the adhesion was inversely proportion with the degree of cross bonding.

The recent studies have shown that MMA monomer substantially increases composite bonding to acrylic resin denture teeth.^{31,32} Papazoglou and Vasilas³¹ stated that this event, in fact, resulted from a mechanic bonding with penetration of the composites into micro irregularities on the surface when MMA was applied to denture teeth due to swelling occurrence, and that there occurred a combination of chemical and mechanic bonding between composites and acrylic denture teeth.

In many in vitro studies the bonding of the acrylic resin and visible light cured resin to the multi-layer synthetic resin teeth or cross bonding acrylic resin teeth were investigated, and determined that they form a high

strength bonding to standard acrylic resin teeth.^{2,32}

In our study, it was determined that the adhesion of repair materials to various brands of teeth used is different as there is no study we encountered, no facility of discussion is found.

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