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Factors Affecting Bonding Strength of Artificial Teeth: A Literature Review

Mohammad Taghi Baghani[1], Niknaz Yahyazadehfar[1], Amirhosein Zamanian[1], Kamyar Abbasi[2], Fereshteh Shanei[3], Shireen Shidfar[3]*, Zahra Zohri[4]

[1]Postgraduate Student of Prosthodontics, Department of Prosthodontics, School of Dentistry, Shahed University, Tehran, Iran
[2]Assistant Professor, Department of Prosthodontics, School of Dentistry, Kerman University of Medical sciences, Kerman, Iran
[3]Postgraduate Student of Periodontics, Department of Periodontics, School of Dentistry, Shahed University, Tehran, Iran
[4] Periodontist, Private Practice

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ABSTRACT

One of the main problems in dental prosthesis is the wear and tear removal and fracture of artificial teeth. The removal of artificial teeth is due to several factors. This review study aims to investigate the factors affecting the bond strength of artificial teeth. Electronic search in pubmed, science direct, google scholar, uptodate, wiley online library with keywords denture bases, artificial, tooth, bonding strength between 2010 and 2017. Acrylic resins provide greater bonding strength with artificial teeth. This may be due to better monomer release at the junction and an increase in the temperature of the polymerization. The type of tooth can also be effective in determining the strength of the bond between the teeth.

Keywords: Gender Selection, PGD, Implantation, Laboratory Embryo
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Corresponding author: Shireen Shidfar
e-mail✉ shidfar_sh@yahoo.com
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INTRODUCTION

Acrylic resin was introduced in 1937, and it has been one of the most used materials in Dentistry [1]. With the advancement of dental technology, it may be assumed that less prosthodontics are used today, but tooth moves are still used to a large extent. Patients prefer to use artificial teeth due to financial constraints and fear of implants and surgery [2]. One of the main problems in denture prosthesis is the wear and tear and fracture of artificial teeth [3, 4]. Detachment of artificial teeth is about 22% in prosthetic restorations. It has been attempted to overcome this problem by partially combining composite resin and ordinary acrylic resin and creating multilithic teeth [5]. In general, two processes are effective in bonding between artificial teeth and acrylic resin. The removal of artificial teeth is due to several factors. To enhance the bond strength, shaving of the surface of the artificial dental floor and the application of various solvents to the surface of the artificial teeth surface can be used. Many studies have been done on the factors affecting the bond strength between artificial teeth. Several factors such as the properties of the teeth used and various resins as well as factors such as surfaces and temperature can be effective[6-8].

MATERIALS AND METHODS

Electronic Search was conducted in a direct scientific article, Google Scholar, up-to-date, Wiley online library with keywords for artificial teeth, artificial teeth, bond strength between 2010 and 2017, and selected articles that are more relevant to the subject.

RESULTS

The artificial molars with the axial sides milled as parallel planes were clamped in to the jaws of the machine; the movement in vertical plane of the bur, at a minimum length of 7 mm inside the molars, under cooling water jet realized the lateral surface of the cylinder.

The effect of solvents on the bond strength of synthetic denture base resin

Identified a method for demonstrating the effect of organic solvents on the bond strength of the resin base of the artificial teeth. In this study, 50 artificial acrylic first upper and lower molars (Spofa Dental) were used for milling 6 mm diameter base and 5 mm height cylinders. The artificial molars with the axial sides milled as parallel planes were clamped in to the jaws of the machine; the movement in vertical plane of the bur, at a minimum length of 7 mm inside the molars, under cooling water jet realized the lateral surface of the cylinder. Synthetic molars with diamond disk and moving in a horizontal plane perpendicular to the cervical axis and axillary molar in a distal direction at a distance of 1 mm below the mucous surface of the acrylic teeth, the first cylinder base was made. The acrylic teeth were removed with crushed lateral surfaces of the cylinder, which removed the walls of the tooth. In this study, the samples were divided into five groups (Table 1). All methods were made using 50 mm alumina, which was made as aluminum oxide within 30 seconds of 10 mm distance. 10 molds were used in size and design for 5 wax samples. The production of wax models involves adjusting in horizontal positions after the plaster was prepared, so that the base of the cylinder was parallel to the other bases. In the preparation and molding of acrylic resin base of artificial teeth in the dough stage, the polymerization process was performed in accordance with the manufacturer's instructions. After completion of polymerization and opening of samples in distilled water, they were kept in distilled water for 30 days at a temperature of 37 degrees Celsius. Subsequently, the samples were tensile tested, using Multitest5i (Mecmesin) at a speed of 1 mm / min. The solvent used in this study was CH2CL2 (Table 2). The results of this study showed that dichloromethane mutually improves the adhesion of acrylic teeth to artificial teeth resin and the strength in group 5 was significantly higher than other groups, which was treated with dichloromethane as a solution. In order to improve the strength of the artificial denture band, it was considered Stoia *et al* [9].

Table 1: Sampling in 5 groups

Group	
Group 1	Polished
Group 2	Polished + methylmethacryla
Group 3	Sandblastin + methylmethacryla
Group 4	Sandblasting + universal repairing adhesive
Group 5	Polished +dichlormethane.

Table 2: Statistical analysis of results using Post Hoc "Scheffe" Test

(I) GROUP	Sig level (α)	Sig	(J) GROUP
Control	0.01	0.004^{S}	Polished + MMA
	0.05	0.285^{ns}	Sandblasting + MMA
	0.001	0.000^{s}	Sandblasting + Kuraray
	0.001	0.000^{s}	Polished + CH2Cl2
Polished + MMA	0.05	0.468^{ns}	Sandblasting + MMA
	0.001	0.000^{s}	Sandblasting + Kuraray
	0.001	0.000^{s}	Polished + CH2Cl2
Sandblasted + MMA	0.001	0.000^{s}	Sandblasting + Kuraray
	0.001	0.000^{s}	Polished + CH2Cl2
Sandblasted + kuraray	0.001	0.000^{s}	Polished + CH2Cl2

Characterized the tensile bond strength between acrylic resin polymerization and acrylic prosthesis of teeth treated with MF-MA solution. In this study, three brands of denture were used (Table 3). Examples of each brand were divided into 10 groups, then samples were applied to each chemical solution. Samples were placed at 60 ° C. The results showed that using MF-MA for 15 seconds could be a chemical replacement treatment for repairing a dental base and rebuilding conventional crossover acrylic teeth. CU acrylic band (MF-MA) and MMA increased bond strength in both teeth. Thongrakard et *al*[10].

Treatment with methyl methacrylate on synthetic teeth showed maximum bond strength. Samples were divided into 4 categories (Table 4).

Table 3: Materials used in the study

Material	Brand name	Composition	Abbreviation	Batch No.	Manufacturer
Denture teeth	Yamahachi New Ace	Polymethyl-methacrylate	YA	HK2017	Yamahachi Dental Mfg., Co., Aichi Pref., Japan
	Major Dent	Polymethyl-methacrylate	MD	2096	Major Prodotti Dentari, Moncalieri., Italy
	Cosmo HXL	Highly cross-linked Polymethyl-methacrylate	CM	20140801C	Dentsply Dental Co., Ltd., Tianjin, China
Autopolymerized acrylic resin	Unifast Trad	Methyl-methacrylate	-	-	GC Dental product corp., Aichi., Japan
Chemical agents	Unifast Trad liquid	Methyl-methacrylate	MMA	-	GC Dental product corp., Aichi., Japan
	CU Acrylic Bond	Methyl formate, Methyl acetate	MF-MA	-	Faculty of Dentistry, Chulalongkorn University, Bangkok, Thailand

Table 4: Partitioning Samples

Group	
Group 1	Denture teeth were repaired with light-cure composite filling material cured for 40 sec without any surface treatment.
Group 2	Denture teeth bonding surfaces were treated with cold-cured methylmethacrylate liquid (monomer) for 3 minutes and then repaired with light-cure composite filling material for 40 sec.
Group 3	Denture teeth bonding surfaces treated with adhesive bonding agent for 40 sec, and then repaired with light-cure composite filling material cured for 40 sec.
Group 4	Denture teeth surfaces treated with cold-cured liquid monomer for 3 minutes, cured with adhesive agent for 40 sec, and then repaired with light-cure composite filling material cured for 40 sec.

The shear bond was then calculated using a universal tensile testing machine and cutting machine. All specimens were tested at the same temperature using the same apparatus the same day. They were dried on the test pieces before being installed. The results showed that there is a significant difference between the shear bond strengths between the surfaces of the teeth compared to the untreated surfaces. Acrylic artificial teeth can affect the shear bond strength between synthetic teeth of acrylic resins and composite resin as a modifying agent Muhsin *et al*[11].

To assess the effect of an additional layer of unfilled resin in self-etch and total-etch dentin adhesives on the shear bond strength (SBS) of composite to dentin. Moreover, we assessed the effects of sample storage in artificial saliva on the SBS of composite to dentin. This experimental study was conducted on 160 freshly extracted human first or second premolar teeth, which were randomly divided into 16 groups. Scotchbond Multi-purpose (SBMP), single bond (SB), Clearfil SE Bond, and Clearfil S3 Bond were applied to dentin surface with or without the placement of hydrophobic resin (Margin Bond) in accordance with the instructions of the manufacturers. To expose the coronal dentin, the teeth were abraded with 600 grit SiC paper. Immediately after restoration, half of the samples were tested in terms of SBS, while the other samples were evaluated in terms of SBS after three months of storage in artificial saliva. SBS rates of dental composites evaluated by universal testing machine and samples were studied by optical stereomicroscopy to verify the failure type. In this stady, a significant reduction was observed in the SBS rates of SB and S3 bond adhesive systems after storage with and without hydrophobic resin. Without storage in normal saline, a significant increase was observed in the SBS rate of the SE bond. In addition, SBS rate of SBMP significantly increased after storage with hydrophobic resin. Finally, the highest and lowest rates of SBS were observed in the SE and S3 bonds in all the experimental groups, respectively. The results of this study showed that effects of using a hydrophobic resin layer on shear bond strength. Nasseri *et al*[12].

Different levels of bond strength in synthetic teeth

Identified the shear bond strength of acrylic teeth to artificial teeth with two types of monomer and silane outer surface coatings. vinyl chloride (PVC) rings of 10 cm height and 0.5inch width were cut from a long pipe. The 10 cm PVC pipes were

adhered to a steel base using sticky wax and sheets of modeling wax was melted and poured till the brim of the PVC pipes, care was taken to fill up all defective areas formed due to shrinking of wax. Then the tooth wax was placed in a flask, and a dental plaster was applied around the PVC, then the cold was applied to dry. The remainder was filled with a mixture of gypsum and stone teeth and compressed for 30 minutes. Then, with warm water, the wax was completely removed from the tooth edge and the PVC ring. In two sets, 96 teeth were divided into three groups (Table 5)Madhav *et al*[13].

Table 5: Categories of teeth

SM1 (control)	**No surface conditioning**
SM2 (monomer)	Two coats of heat cured monomer is applied over the ridge lap area and they were left to evaporate for 5 minutes.
SM3 (silane)	Two coats of silane coupling agent was applied over the ridge lap area and they were left to evaporate for 5 minutes.

In their study, they evaluated the bond strength of acrylic teeth to the acrylic dental base. Amino acids were significantly improved in bond strength by using different surface preparation agents such as monomer and silane. For the shear bond strength of the sample, the control agent is <monomer < silane. Different surface methods have been identified for the tensile bond strength between acrylic resin teeth and synthetic dentures. In this study, 30 acrylic resin teeth were selected and treated in three different levels (Table 6). The rectangular molds were dimensioned (17mm, 10mm, 7mm, 9mm, 3mm). Then the teeth were placed on the spoil surface and a rectangular wax block was wrapped up. Each denture was 45 degrees. The tensile bond strength test was performed using a load cell with a crosshead, loaded at a speed of 0.5 mm / min. Then the data was recorded and the bond strength was calculated according to the form $T.S = \frac{F}{S}$ and $S = \frac{\pi^2}{4}XD$ was calculated. Table 6 shows descriptive statistics of band strength in study groups. The results of this study showed that high band bond strength of acrylic teeth to acrylic teeth with metal wire in the untreated group was obtained. Also, adding glass fiber can increase the tensile bond strength. Yaseen *et al*[14].

Examined the shear bond strength at three different correctional levels. In their study, they used 40 acrylic teeth divided into 4 test groups. The teeth in each group were one of three different surface changes, namely, chemical treatment, sandblasting and insertion of retaining grooves in the edges. Then the strength was tested by the global machine. The results indicated that the insertion of the grooves retained or increased bond strength, while chemical treatment did not show any increase in the shear bond strength Mahadevan *et al*[15].

Cross linking of the acrylic teeth were done to improve the properties of the resin such as fracture, abrasion and staining resistance. But, on the basis of bonding strength the cross linked teeth don't provide good bonding strength Strongest bond was obtained between heat cured resin and plastic teeth. Representative makes of conventional artificial teeth were chosen to be bonded to two types of denture bases: heat and visible light cured denture bases. A total of 120 acrylic teeth and 80 porcelain teeth were used in the study. All denture teeth were maxillary central incisors for all specimens, the interface where failure occurred were inspected. The failure was classified as either adhesive or cohesive in nature. In this study The results showed Effect of surface treatments, Effect of curing techniques, Effect of thermocycling. All the data from the experiment were separated according to the artificial teeth type, the denture base type and before and after thermocycling. Fatah *et al*[16].

Table 6: Descriptive statistics. Distribution of mean tensile strength in study groups

Studies group	Mean	Standard deviation	Stander error	Minimum	Maximum
First group (control)	0.19	0.021	0.006	0.16	0.22
Second group	0.23	0.0205	0.0065	0.21	0.26
Third group	0.26	0.0188	0.0059	0.24	0.29

The effect of polymerization temperature on bond strength

Glossy surface of the ridge-lap area of the acrylic teeth unmodified. Group II: Glossy surface of the ridge-lap area of the acrylic teeth abraded. Group III: Preparation of retentive grooves on the lap area of the acrylic teeth. Effect of polymerization temperature on bond strength, by comparing two different treatments. In this study, three groups were used: the first group: Glossy surface of the ridge-lap area of the acrylic teeth unmodified.

Group 2: Glossy surface of the ridge-lap area of the acrylic teeth abraded. Group 3: Preparation of retentive grooves on the lap area of the acrylic teeth. All three groups were attached to a waxy portion, and the wax pattern was such that only the edge of the tooth was in contact with the wax. During the short treatment period, it was immersed in the baking cycle at room temperature and then increased at a temperature of 75 ° C for 90 min. Polymerization. Then the temperature increased to 100 ° C and kept for 60 minutes. In a slow cycle, they were placed in this cycle at room temperature then increased at a temperature of 75 ° C for 8 hours. Then they were placed in solution for half an hour and the samples were examined. They were then kept in water for 24 hours. Tensile bond strength test was performed for samples. The results showed that the tensile bond strength of the slow-cured cyclic samples was better than the short-cycle, and the slow cycle with open openings showed the highest tensile bond strength. Noufal *et al*[17]. Investigated the effect of increasing the temperature by autoclave on shear bonding in their own study of artificial teeth on the base materials of artificial teeth. In their study of thermal polymerization (Vertex), they used a high heat-acrylic effect. In the first group (control), acrylic resins were boiled for one hour and a half and then 30 minutes at 74 ° C. The second group of acrylic resins was placed in a 121 ° C autoclave for 30 minutes. The results showed that autoclaving polymerization can be effective as an alternative to denture resin processing. The autoclave can increase the shear bond strength. Mustafa *et al*[18].

The most common failure in dentures is the loss of adhesion between the base and acrylic denture teeth. It has been stated that some disinfectant solutions may cause changes in the physical and mechanical properties of denture base acrylic resins and artificial teeth. The bonding between the artificial tooth and acrylic resin depends on the swelling of monomers from the denture base to the polymeric matrix of the acrylic resin tooth at the bond interface. Bond Strength of Artificial Teeth Attached to a Microwave-Polymerized Denture Base Resin after Immersion in Disinfectant Solutions, in this study, Eighty specimens were made from a conventional acrylic resin and crosslinked resin teeth attached to a microwave denture base. The specimens were divided into eight groups (n = 10) according to the immersion solution: 2% chlorhexidine digluconate, 1% sodium hypochlorite, Corega tabs, and distilled water, control. A stainless steel mold was used to fabricate silicone patterns. with a circular opening (5.0 mm diameter × 2.5 mm length), to standardize the dimensions of the denture base resin cylinders.These silicone patterns were glued to the embedded teeth, and then each circular opening was filled with silicone before the flasking procedures. Each embedded tooth/ silicone pattern set was flasked using dental stone. After the dental stone was set, the silicone was removed from the circular opening, and the microwave-polymerized denture base resin Nature-Cryl MC was mixed, packed, and processed according to the manufacturer's instructions. A microwave oven was used to polymerize the denture base resin for 3 minutes at 500 W. then Shear bond strength tests were performed using a universal testing machine at a 0.5 mm/min crosshead speed. The comparisons were made among the data of the maximum stress (MPa) required to shear the denture base resin off the acrylic tooth. The results showed that the bond strength at the interface between different types of denture base resins and acrylic teeth should be evaluated when submitted to immersion in denture cleansers. so, in this study, amicrowave-polymerized denture base resinwas used to bond to two types of acrylic teeth. From the results of this study, the null hypothesis was rejected, since the bond strength between artificial teeth and a denture base resin was affected by the two factors evaluated pero *et al*[19].

Table 7. Partitioning of tested specimens

Group	
Group 1	with specimens realized with ceramic teeth and self-curing resin bases
Group 2	with specimens realized with ceramic teeth treated with aluminium oxide sandblasting and self-curing resin bases;
Group 3	with specimens realized with ceramic teeth and thermal-curing resin bases treated with pressure injection moulding;
Group 4	with specimens realized with ceramic teeth treated with aluminium oxide sandblasting and thermal-curing resin bases treated with pressure injection moulding;
Group 5,6,7,8	with specimens treated as for Groups A, B, C and D, respectively, but including acrylic resin teeth.

Effect of different types of artificial teeth on bond strength

Examined the shear bond strength of various resins and artificial teeth made of ceramic and acrylic resin materials. They were performed on 80 samples, divided into 8 groups (Table 7). The results showed that the shear bond strength depends on the tooth base to dental materials, base materials, sandwiches. Between shear bond strengths for teeth made of different materials, the highest strength is for teeth made of acrylic resins, thermal resin bases and aluminum sandblast teeth. Corsalini *et al*[20].

Investigated the reconstruction of artificial teeth and evaluated the varying thickness of acrylic resins on the strength of bond strength. They used 52 thermal polymerization samples of acrylic resin. The specimens were then broken down by a global device. After reconstructing the samples, the results showed that the bond strength of one tooth was increased by the effect of acrylic resin thickness, and also the heat increased bond strength. Clark *et al*[21].

The Effect of Different Types of Resin Base Prosthesis and Polymerization Methods on Bond Strength

Characterized the bond strength of acrylic artificial teeth modified with composite resins and cure light. The results showed that using bonding in composite resins and acrylic resin of artificial teeth increases bond strength. Muhsin *et al*(11). used a visible optical polymer resin (VLD) as a temporary agent for strength. The results showed that bond strength to VLD resin could be increased and can be used for temporary bond strength in dentistry for definitive prostheses. This method is a convenient way to increase the bond strength of artificial teeth. Segal *et al*(22).

DISCUSSION

There are many variations in the methods and materials used to evaluate the strength of the teeth. Several factors affect the strength of joint teeth, each of which can have definite effects on this strength. The strength of teeth bonding to different resins is also different, acrylic resins provide greater bonding strength with artificial teeth[20, 21]. This may be due to better monomer release at the junction and an increase in the temperature of the polymerization [11]. The type of tooth can also be effective in determining the strength of the bond between the teeth [17, 18]. Acrylic artificial teeth will have a stronger torsion than other prosthetics. Also, the heat will increase the bond strength in the acrylic teeth. The use of solvent substances such as dichloromethane on artificial teeth increases the strength of the bonding of artificial teeth [9]. Another study also considered the use of methyl methacrylate to increase strength [11]. Several studies have been carried out to compare the different levels for increasing the bond strength, which showed that the level of the cylinder and retaining grooves can increase the strength of the bonding of artificial teeth [13-15]. Composite resin materials also increase bond strength. the null hypothesis was rejected, since the bond strength between artificial teeth and a denture base resin was affected by the two factors evaluated [19]. Plaque retention as well as poor strength may be related to a relatively high degree of porosity found in VLP resins. The volume of porosity is related to the fact that the resins cannot be polymerized under pressure [23]. Training potential due to water sorption may be a limiting factor in its suitability as a definitive denture base material. The bond strength cannot directly be compared to those of other investigators due to differences in methods. This is a common statement among investigators of bond strength of denture teeth. Several countries have their own national specifications, and they each have very different methods for evaluating bond strength. Several investigators have acknowledged the limited clinical applicability of these tests [21]. Investigators are continually trying to make a more clinically applicable testing method. The benefit of using diatoric groove may be explained by that, the diatoric provide a wider contact area with denture base resin and greater mechanical retention and, increases the surface area on the artificial teeth available for the polymerizing denture base to interact with. Also, the diatoric of the denture base resin embedded in the artificial tooth creates a path of resistance to fracture in a direction different from the tooth denture base interface. These mechanically strengthen the bond between the artificial tooth and the denture base [12, 16]. When used on acrylic denture teeth as a surface treatment, a methyl formate-methyl acetate solution acts by swelling and dissolving their surfaces, and then evaporating. In addition, there are no carbon–carbon double bonds in methyl formate or methyl acetate molecules to polymerize with the monomer in the auto-polymerized acrylic material. Thus, it would not obstruct the interlocking of the auto-polymerized

resin polymer chains and the denture teeth, and the tensile bond strength would be increased[10]

CONCLUSION

It can be concluded that the attachment of artificial teeth is complex phenomenon that has several factors in the strength of bonding and fracture prevention. Paying attention to the factors that make dentin prosthesis stronger can increase the strength of the teeth to the base, reducing the patient's future therapeutic needs and also increasing the durability of the prosthesis.

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