

Impact of Different Surface Treatments of Acrylic Teeth on Shear Bond Strength of Injection Moulded Denture Base Material

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ABSTRACT

Background: To evaluate the effect of different surface treatments of acrylic teeth on shear bond strength of injection molded denture base material. It also determined the influence of retentive grooves, airborne particle abrasion and the chemical treatments (Ethyl acetate & Cyanoacrylate) on shear bond strength between acrylic teeth to injection molded denture base material.

Materials & Methodology: Hundred wax samples made by using the putty index by pouring the melted wax in the putty index. After cooling, the wax patterns retrieved from the putty index. A total of 100 acrylic teeth (Acryrock) divided into different groups depending on the surface treatments (horizontal grooves, Abrasion by 50µm Al₂O₃, Ethyl acetate, Cyanoacrylate) on the ridge lap surface of the acrylic teeth. These wax patterns are attached through sprues and invested in the IVOCAP flask, and dewaxing is done using Electronic Dewaxing bath at 85°C for ten minutes, and curing is done. The obtained 100 acrylic samples tested for shear bond strength between samples and denture base materials using 50 KN universal testing machine.

Results: The results showed that the ethyl acetate surface treated group had significantly superior shear bond strength to the denture base resin when compared with cyanoacrylate surface treated teeth, mechanical groove prepared teeth, sandblasted teeth and control group.

Conclusion: Among the test specimens, the shear bond strength and surface treatments between acrylic resin teeth with injection molded denture base resin was superior to the ethyl acetate group.

Keywords: Surface treatments, Shear bond strength, Injection molded denture base material (SR-Ivocap high impact material) and Acrylic resin teeth.

INTRODUCTION

Profound effect on aesthetics and functions of the stomatognathic system seen because of tooth loss; replacement of teeth by artificial substitutes such as partial, complete/fixed dentures is vital. For many years, porcelain was the favourite tooth material

because of the rapid wear of acrylic resin. However acrylic teeth gained popularity over porcelain teeth because of their inherent problems such as brittleness, susceptibility to crazing (denture base), a clicking sound, difficulty in grinding, need for

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mechanical retention and abrasion of opposing natural teeth and gold surfaces. Advantages of acrylic resin teeth over porcelain teeth was their ability to bond chemically to denture base resin, higher fracture toughness, less bone resorption and were economical. In Prosthodontic practice debonding of denture teeth from the denture bases is a significant problem. The various factors that attributed to bonding failures are as follows: 1. Faulty wax elimination. 2. Contamination leaving remnants on the ridge lap surface of the teeth. 3. Improper application of separating media, tinfoil substitute. 4. The presence of foreign materials.

Attempts to increase the strength of the bond between resin teeth to denture base resin includes; 1. Glossy ridge lap surface grinding. 2. Painting ridge lap surface of teeth with monomer solution. 3. Cutting retention grooves on ridge lap surface of teeth. 4. Use of detergent solution on ridge lap surface of teeth during wax elimination.

MATERIALS & METHODS

Preparation of wax patterns: - A hollow aluminium block prepared, and a wax sample of 15×15×10 mm prepared for duplication of 100 similar samples. Putty indexing made for wax samples using aluminium blocks as trays. (Figure-1) Hundred wax samples made by using the putty index by pouring the melted wax in the putty index. After cooling, the wax patterns retrieved from the putty index. A total of 100 acrylic teeth (Acryrock) divided into different groups depending on the surface treatments on the ridge lap surface of the acrylic teeth.

Table 1: Samples and corresponding surface treatment.

S.no	Sample number	Surface Treatment
1.	20	Nil
2.	20	Horizontal grooves
3.	20	Abrasion by 50µm Al ₂ O ₃
4.	20	Ethyl acetate
5.	20	Cyanoacrylate

Teeth are representing each of the five groups manually positioned and fused into the fabricated wax patterns. These wax patterns are attached through sprues and invested in the IVOCAP flask, and Dewaxing is done using electronic dewaxing bath at 85°C for ten minutes. Simultaneously IVOCAP (High impact denture base material) capsule mixing is done using capsule vibrator (Mechanical), which consists of di-benzyl peroxide polymer and methyl methacrylate, ethylene glycol dimethacrylate monomer. Each capsule contains a polymer of 20mg and monomer of 30ml. (Figure-2)

After that, the separating media applied into the de-waxed sections of the IVOCAP flask and clamping is done using the ivocap clamp. Admixed material is injected into the flask using the injection moulding technique, followed by curing using electronic acrylizer. (Figure-3)

Curing is done by the following method, at first bench pressing is done for 10 min followed by heating at 100°C, 6psi for 35 min followed by cooling at < 30°C for 45 min using ivocap injection system. (Figure-4)

A total of 11 capsules of ivocap material used for 100 samples (9 samples per flask). The material used was SR-IVOCAP HIGH IMPACT heat cure denture base material, EN ISO 20795-1, Type 1, class I, Ivoclar Vivadent AG, FL-9494. Schean/Liechtenstein. (Figure-5)

After cooling, deflasking made, sprues cut and trimming and polishing of acrylic samples were done using acrylic burs, sandpapers, polishing buffs and pumice. (Figure-6) These samples tested for shear bond strength using 50 KN universal testing machine. (Figure-7)

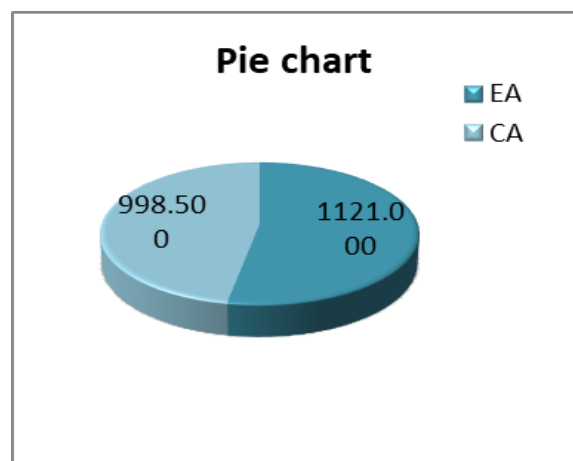
RESULTS

The results showed that different surface treatments on the ridge lap surface of acrylic resin teeth would enhance the shear bond strength of the bond between injection molded denture base resin and acrylic teeth.

Table 2: t-test comparison of all combinations.

SL.NO	GROUPS	N	Mean	Std. Deviation	t-test	p value	Sig
1	Control	20	877.500	122.480	4.225	0.000	**
	Mechanical	20	1045.750	129.313			
2	Control	20	877.500	122.480	2.660	0.011	**
	SB	20	996.250	157.713			
3	Control	20	877.500	122.480	5.900	0.000	**
	EA	20	1121.000	138.056			
4	Control	20	877.500	122.480	3.332	0.002	**
	CA	20	998.500	106.624			
5	Mechanical	20	1045.750	129.313	1.085	0.285	@
	SB	20	996.250	157.713			
6	Mechanical	20	1045.750	129.313	1.779	0.083	@
	EA	20	1121.000	138.056			
7	Mechanical	20	1045.750	129.313	1.261	0.215	@
	CA	20	998.500	106.624			
8	SB	20	996.250	157.713	2.662	0.011	**
	EA	20	1121.000	138.056			
9	SB	20	996.250	157.713	0.053	0.958	@
	CA	20	998.500	106.624			
10	EA	20	1121.000	138.056	3.141	0.003	**
	CA	20	998.500	106.624			

SB- Sand blasting, EA –Ethyl acetate, CA- CyanoAcrylate

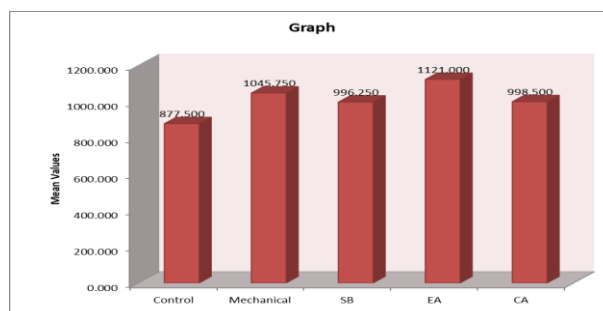


Graph 1: Distribution of EA and CA

Shows comparison of mean shear bond strength of acrylic resin teeth with SR-Ivocap high impact denture base material between ethylacetate group and cyanoacrylate group. Ethylacetate group showed increased shear bond strength than cyanoacrylate group.



Graph 2: Graph showing shear bond strength.



Graph 3: Shows comparison of force required to separate acrylic resin teeth from the SR-Ivocap high

impact denture base resin. Ethyl acetate showed highest shear bond strength (Newtons) than others.

DISCUSSION

Ravi SY¹ et al. inferred in his study the advantages of acrylic resin teeth over porcelain teeth was their ability to bond chemically to denture base resin, higher fracture toughness, less bone resorption and were economical. The highest shear bond strength found in the ethyl acetate treated group than the mechanical grooves prepared teeth, cyanoacrylate treated group, sandblasting done group, and control group. These findings correlate with the results of Ravi SY¹, who conclude that the ethyl acetate treated group requires greater force to separate the tooth from the denture base.

Jain G² et al. inferred in his study about the effect of different chemical surface treatments of denture teeth on shear bond strength. The application of dichloromethane showed increased bond strength between cross-linked acrylic resin teeth and heat cure denture base resin followed by monomethyl methacrylate monomer and control group. They concluded that the application of dichloromethane on the ridge lap surface of the resin teeth before packing of the dough into the mold significantly increased the bond strength between cross-linked acrylic resin teeth and heat cure denture base resin.

Chung-Jae LEE³ et al. revealed that the mean palatal adaptation of injection molding denture bases was statistically significant when compared to compression molding denture bases in both the shallow palate and deep palate. The Injection molding denture bases had better palatal adaptation. The material of choice and the technique of processing plays a significant role than the shape of the vault in deciding the palatal adjustment of the denture.

Sykora⁴ et al reported that higher dimensional accuracy of the injection-molding technique, in comparison to the conventional method, may be related to smaller resin particles compared to the conventional acrylic resin, lower polymerization temperature, absence of resin film formation between the two halves of the flask, and absence of displacement of the two halves of the flask during resin packing. SR-Ivocap injection procedure had

higher dimensional accuracy compared to conventional molding.

Nogueira SS⁵ et al. demonstrated the observation of real working time and waiting time, although the groups had a similar actual working and waiting times and the same curing cycles, dentures produced by the injection system would save time in the laboratory compared with the compression molding technique because of the smaller incisal pin opening.

Bahrani F⁶ et al. studied the effect of surface treatments on shear bond strength of denture teeth to denture base resins. The surface treatment of the denture teeth significantly affected their shear bond strengths to both the denture base resins. Bahrani F concluded that the monomer application and airborne particle abrasion of the ridge lap area of the denture teeth improved their shear bond strengths to the denture base resins regardless of the type of polymerisation.

Cardash HS⁷ et al. observed that the contamination of tooth with tin foil substitute resulted in a 56% reduction in bond strength. Mustafa MJ⁸ et al. revealed that chemical and mechanical treatment of acrylic teeth improved the shear bond with heat cure and high impact acrylic, and also autoclave processing improved the shear bond with acrylic teeth in high impact acrylic. Pryor WJ⁹ et al. observed that with the use of this technic in curing acrylic resins, the denture will be tough and robust with almost no breakage in use, porosity eliminated.

Rupp NW¹⁰ et al. verified in temporary dentures made of a compression molded- and a pour type poly(methyl methacrylate) and concluded that compression molded technique is beneficial rather than pour type method. The present study showed that the shear bond strength between the denture teeth and denture base was highest when the teeth ridge lap surface treated with ethyl acetate, followed by mechanical retentive grooves prepared group, cyanoacrylate treated group, sandblasting done group, control group (without any surface treatments on the ridge lap surface of acrylic teeth).

There is a significant difference between the groups and not within the groups. There is a significant difference between the control group and mechanical group, control group and ethyl acetate

group, control group and cyanoacrylate group, control group and sandblasting group, sandblasting group and ethyl acetate group, ethyl acetate group and cyanoacrylate group.

SUMMARY & CONCLUSION

i. Among the test specimens, the shear bond strength between acrylic resin teeth with injection molded denture base resin was superior with the ethyl acetate group when compared with cyanoacrylate group, mechanical groove group, sandblasted group and control group.

ii. Observed that surface treatments of acrylic resin teeth (Acryrock) increased the shear bond strength between the teeth & the denture base material when compared to the control group.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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