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COMPARATIVE EVALUATION OF HARDNESS OF DIFFERENT TYPES OF DENTURE TEETH AFTER IMMERSION IN WATER AT DIFFERENT TIME INTERVALS: AN IN-VITRO STUDY

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ABSTRACT

Statement of problem: Wearing of denture teeth is a frequent problem which may affect esthetics of the patient. **Materials and method:** Three commercially available denture teeth were selected - Cross linked acrylic resin teeth, Highly cross linked acrylic resin teeth and Composite resin teeth. Ninety samples of all three test materials were fabricated (30 from each material) which were divided into two groups, Control group and Experimental group. In control group 30 samples of three test materials (10 from each material) were not immersed in water while in experimental group 60 samples were immersed in water, at 24 hours and 90 days and Vickers hardness test was performed. **Result:** composite resin teeth showed maximum hardness. ANOVA showed statistically significant result as $p<0.001$at 90 days immersion. **Conclusion:** There is a decrease in hardness of all the three types of denture teeth after immersion in water.

INTRODUCTION

Edentulous state is considered as a social and psychological catastrophe by majority of people. The basic objectives of complete denture prosthodontics are the restoration of function, facial appearance, and the maintenance of patient's health. The complete denture wearer should be able to speak distinctly and experience oral comfort.[1,2]

Artificial teeth and denture base material must have good mechanical and physical properties. The artificial teeth should not only mimic the anatomical and esthetical details, but should also be biocompatible, inexpensive, wear resistant and absorb some of energy during function.[3,4] Earlier artificial teeth were made from wood, bone, porcelain, acrylic resin and more recent composite resin teeth are available.

Wear of denture teeth affects the occlusion and vertical dimensions that is important for esthetics and comfort of the patient. Hardness, which is a relative resistance of a material to denting, scratching or bending is one of the important properties. Denture teeth are always in contact with saliva or in water, the artificial denture teeth may absorb water or saliva because they are in direct contact throughout their service. So, it is very important to evaluate the effect of water on hardness of artificial denture teeth whether it may interfere with mechanical properties of denture teeth material or not. The purpose of the study is to evaluate the hardness of denture teeth when immersed in water at various time intervals.

MATERIALS AND METHOD

Three commercially available different denture teeth were selected- Cross linked acrylic resin teeth (CLAT) Premadent (Super dental products, Delhi, India), Highly cross linked acrylic resin teeth (HCLAT) Cosmo HXL (Dentsply India Pvt Ltd, Delhi, India) and Composite resin teeth (CRT) Efucera A (Shefu Inc, China). Ninety samples of all three test materials were fabricated (30 from each material) which were divided into two groups, Control group and Experimental group. In control group 30 samples of three test materials (10 from each material) were not immersed in water while in experimental group 60 samples were immersed in water, at 24 hours and 90 days and Vickers hardness test was performed.

Fabrication of specimens

A custom-made stainless-steel metal mould measuring 15x15x5 mm was fabricated. The stainless steel mould was kept on flat surface and modelling wax was filled into it. When the wax was about to set, specimen tooth was embedded into it. The occlusal surface of the tooth was kept parallel to the floor and 2mm above the metal mould. After setting of the wax, excess wax was removed and the pattern was retrieved. Ninety such specimens were fabricated. (Figure 1).

Wax patterns were invested in Hanau flask using dental stone (Kalastone). After final setting of the dental stone, dewaxing was done and Travelon heat cure denture base acrylic resin (Denstply India) was packed using 3:1 by volume ratio. Short curing cycle was used for polymerization.

Acrylic resin sample blocks retrieved from the flask and excess material was trimmed. The occlusal surface of the tooth was ground flat at the level of resin block with carborundum disk no. 37. Carbide paper no. 80, 100 and 320 was then used to smoothen the teeth blocks. Acrylic teeth were polished using pumice and composite teeth were polished using composite polishing wheels no. 23810, 2381M, 2381F and 2331SF.

Hardness Testing

A VIK Hardness tester was used to determine the hardness. The sample was placed on platform and 1kg load was applied and a diamond pyramid indentation was created on the occlusal surface of each tooth. Three such indentation was marked, averaged and mean was calculated. All the data collected were statistically analyzed. (Figure 2)

RESULTS

Hardness values for various materials showed that it decrees after prolong immersion in water. Maximum value of hardness was observed in composite resin teeth group ie. 41.003 VHN and minimum in crosslinked acrylic resin group ie. 40.097 VHN (table 1). Analysis of variance ANOVA with post hoc comparison showed that highly cross-linked acrylic resin teeth with composite resin teeth at 24-hour immersion was not significant as p value is 0.03. At 90 days immersion all the material groups showed significant differences as p value is <0.001.

Table 1: Analysis of hardness of materials.

Group	Time	N	Mean	Std. Deviation	Minimum	Maximum
CLAT	Control	10	40.097	0.483	39.2	40.8
	24 Hrs	10	39.987	0.475	39.1	40.7
	90 days	10	38.883	0.493	38	39.7
	Total	30	39.656	0.73	38	40.8
HCLAT	Control	10	40.597	0.457	39.8	41.5
	24 Hrs	10	40.567	0.527	39.5	41.4
	90 days	10	39.517	0.62	38.1	40.4
	Total	30	40.227	0.734	38.1	41.5
CRT	Control	10	41.003	0.543	39.9	41.9
	24 Hrs	10	40.95	0.636	39.5	41.9
	90 days	10	40.09	0.458	39.3	40.9
	Total	30	40.681	0.686	39.3	41.9
Total	Control	30	40.556	0.631	39.2	41.9
	24 Hrs	30	40.511	0.658	39.1	41.9
	90 days	30	39.497	0.72	38	40.9
	Total	90	40.188	0.829	38	41.9

Table 2: Analysis of variance ANOVA.

Time period		Sum of squares	Df	Mean square	F- test	p-values	Post-Hoc Comparisons (p-values)	
Control	Between groups	12.336	2	6.168	23.245	<0.001	CLAT vs HCLAT	0.002
	Within groups	23.086	87	0.265			CLAT vs CRT	<0.001
	Total	35.422	89				HCLAT vs CRT	<0.004
24 hours	Between groups	14.25	2	7.125	25.488	<0.001	CLAT vs HCLAT	<0.001
	Within groups	24.319	87	0.28			CLAT vs CRT	<0.001
	Total	38.569	89				HCLAT vs CRT	0.03
90 days	Between groups	21.859	2	10.929	39.145	<0.001	CLAT vs HCLAT	<0.001
	Within groups	24.29	87	0.279			CLAT vs CRT	<0.001
	Total	46.149	89				HCLAT vs CRT	<0.001

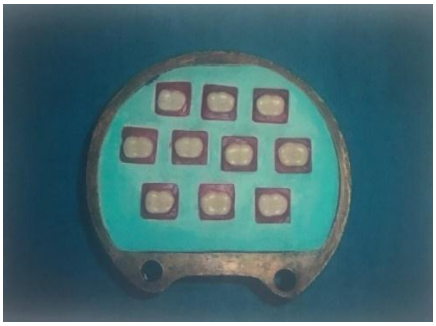

Figure 1: Invested samples.

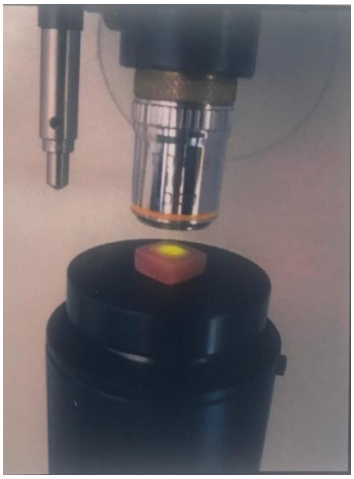

Figure 2: Vicker's Hardness Test.

DISCUSSION

The hardness of three different types of commercially available denture teeth were evaluated after polishing of the samples because polished denture was inserted in patient mouth. Vickers hardness test was used because it is a standard method for measuring the hardness of denture teeth and various workers Pavarina AC et a[5], Zeng J et al[6] Medeiors IS et al[7], also used this test to determine the hardness of artificial denture teeth.

Results of the study indicated that composite resin teeth had highest hardness value when compared to other groups. The increase in hard ness of composite resin teeth may be due to presence of filler particles like silica and quartz etc[8]. Improve in the hardness of highly cross linked teeth can be attributed to the cross linking nature of the material. In cross linking, slippage between polymeric chains cannot occur and the material becomes more difficult to soften and it also reduces the tendency of the artificial resin teeth to craze under occlusal forces.[5,9,10]

In the present study, the decrease in hardness after immersion in water is because water interferes with the polymeric chains and affect hardness by producing a plasticizing effect on the polymerized material.[2,3]

In composite resin denture teeth, the hardness was decreased due to water sorption. The water absorbed by polymer matrix can cause filler matrix debonding or even hydrolytic degradation of the fillers. According to Medeiros et al[7] chemical degradation occurs via hydrolysis which is a complex process. After water or solvents enter the polymer bulk, the intrusion of water triggers chemical polymer degradation, leading to the creation of oligomers and monomers. Progressive degradation changes the microstructure of the composite bulk through the formation of pores, via oligomers, residual monomers, degradation products and addictive are released.

The clinical implication of the study is to use composite resin teeth or highly cross linked teeth in denture fabrication.

CONCLUSION

Within the limitation of the study the following conclusions were drawn:

- The hardness of composite resin teeth was found maximum among all the tested denture teeth.
- Immersion of artificial teeth in water after 24 hours decreases the hardness but the decrease is not significant.
- There is a significant decrease in hardness of all the three types of denture teeth after 90 days immersion in water.

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