

Evaluation and Comparison of the Abrasion Resistance and Microhardness of Artificial Acrylic Teeth

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ABSTRACT

Background: This study was undertaken to evaluate and compare the abrasion resistance and microhardness of the following artificial acrylic teeth Cavitax (India), Ivostar (Ivaclar, Vivodent, Liechtenstein, USA), Acryplus (Ruthium, Italy)

Materials & Method: The present study is an in-vitro study conducted to evaluate and compare the abrasion resistance and microhardness of six different types of commercially available artificial acrylic teeth (Cavitax, Ivostar, Acryplus). 12 samples of each brand were evaluated for abrasion resistance employing Taber abrader testing machine and for microhardness Vickers hardness tester was used. After statistical analysis Mann-Whitney U test.

Results: Mean $\pm$ SD of abrasion resistance in Cavitax, Ivostar, Acryplus, groups were 0.003 ± 0.001 , 0.005 ± 0.001 , 0.008 ± 0.001 respectively. Mean $\pm$ SD of microhardness in Cavitax, Ivostar, Acryplus groups were 19.68 ± 1.91 VHN, 30.95 ± 1.37 VHN, 39.15 ± 1.15 VHN, respectively. Conclusion: Group 3 (Acryplus) showed maximum abrasion resistance & maximum microhardness.

Conclusion: It was found that all of the samples tested Group 3 (Acryplus) had the maximum surface abrasion resistance and microhardness value.

Keywords: Denture, Microhardness, VHN, Abrasion Resistance.

INTRODUCTION

The first attempt to make dentures which are comparable to the current times was done in 1850's by Nelson Gogger and Charles brother who developed hard rubber called "VULCANITE". The dentures made out of vulcanite, fitted well and were relatively cheaper for the common man, but it was difficult to modify the colour, the material was porous causing food lodgement, it had lack of translucency leading to poor esthetics and were relatively unhygienic¹. It was only in 1937 when Dr. Walter Wright introduced resin 'Polymethyl

methacrylate' to dentistry¹. Polymethylmethacrylate revolutionized the way teeth were replaced in those days, not only the denture bases but also the artificial teeth were made using acrylic resin from earlier part of 20th century.²⁻³

Over the years acrylic teeth have been modified to overcome the disadvantages of excessive wear by using cross linking agents, different monomer and addition of filler particles. The manufacture of these modified cross linked teeth have better wear

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resistance, higher grinding strength, and better crazing resistance.

Hardness, which is related to wear resistance and is an indicator of the mechanical properties of artificial acrylic teeth. Abrasion is wearing down, marring or rubbing away of acrylic tooth surface. By checking for hardness and abrasion resistance of different commercially available teeth an estimate of their longevity can be made.^{4,5}

There was a dearth of literature which can compare the wear resistance and microhardness of commonly available cross linked acrylic teeth. This study was there for undertaken to evaluate and compare the abrasion resistance and microhardness of the different artificial acrylic teeth.²

MATERIALS AND METHODS

Materials: 3 brands of semi anatomic acrylic denture teeth.

1. Cavitax(India)
2. Ivostar(Ivaclar,Liechtenstein,USA)
3. Acryplus(RuthinumgrItaly)

Inclusion criteria-

1. Only cross- linked teeth were used.
2. Only **ISO** (International Organization for Standardization) approved teeth sets were used.
3. Two different types of teeth of each brand used for particular test.
4. For each brand the Samples were selected were of the same batch.

Exclusion criteria-

1. Non cross-linked teeth were not included.

Methodology

Grouping of specimen

For Abrasion Resistance	For Microhardness
Group 1(Cavitax)n=12	Group 1(Cavitax)n=12
Group 2(Ivostar) n=12	Group 2(Ivostar)n=12
Group 3(Acryplus)n=12	Group 3(Acryplus)n=12

From all the teeth set Maxillary and mandibular Right and left central incisors, Canines and first molars were used. To mimic the clinical condition the samples were first stored in distilled water for 24 hrs. to allow water absorption.

Testing of sample was done at **Central Institute of Plastics Engineering & Technology (CIPET),Bhopal**. These samples were tested on Taber abrader testing machine (5131). Since the dimension of the samples to be tested was small, round disc shape base(diameter-11.5mm, thickness-1mm) was made out of self-cure acrylic resin. This was done so that the sample could be tightly held on the testing machine. The samples were weighted and reading were noted and tabulated as control group. The samples were first immobilized on machine and then the abrasion cycles were started with frequency of 1000 cycles with loading of 1000 grams; thereafter tooth surfaces was sandblasted with 600µm silicon carbide particles. After completing 1000 cycles the samples were weighted again and the results were noted and tabulated again.

Testing of samples for microhardness was done at **Advanced Materials and Processes Research Institute (AMPRI),Bhopal**. The samples were tested on Vickers Hardness testing machine (Leica Germany). Since the dimension of the samples to be tested was small, round shape base (Diameter 20mm,Height-6mm) was made out of self-cure acrylic resin. This was done so that the sample could be tightly held on the testing machine. The microhardness were tested on Maxillary and mandibular Right and left central incisors, Canines and first molar. The cross sections surfaces were observed using a microscope ((Motic,Asia)at 15 magnification to determine the number of layers constituting the structure of each type of tooth. The hardness of each brand was determined with Vickers hardness tester (Leica, Germany) at 300gf load and dwell time 10 seconds, One indentation were measured on each specimen. The diamond shape indentation were observed in an optical microscope with a digital camera. The length of the two diagonal was used to calculate the microhardness (Vickers hardness) value. The representative value for each sample was obtained as the average of the results for indentation and the results were noted and tabulated.



Fig 1: Cavitax (API, India)



Fig 2: Ivostar (Ivoclar, Liechtenstien, USA)



Fig 3: Acryplus (Ruthinum, Italy)



Fig 4: Digital stereo microscope.

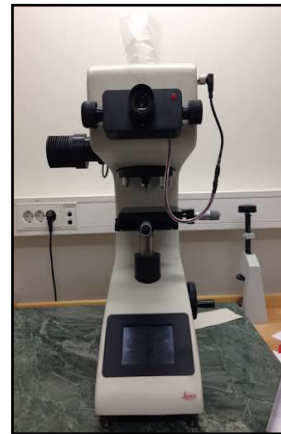


Fig 5: Vickers hardness testing machine.

RESULTS

The study was carried out to evaluate and compare the abrasion resistance and micro hardness of three types of artificial acrylic teeth.

Table 1: Comparison of abrasion resistance between different types of artificial acrylic denture teeth.

Groups	Abrasion resistance	
	Mean ± SD	Min-Max
Group 1 (Cavitax)	0.003± 0.001	0.002-0.004
Group 2 (Ivostar)	0.005± 0.001	0.003-0.006
Group 3 (Acryplus)	0.008± 0.001	0.006-0.008
Kruskal-Wallis test	$\chi^2 = 40.796$, df=5, P = 0.000 (<0.001) Very high significant	
Mann-Whitney U test: -		
Group 1 and Group 2	MW = 3.000, P = 0.002 (<0.01), Highly sig.	
Group 1 and Group 3	MW = 0.000, P = 0.000 (<0.001)Very high sig.	
Group 2 and Group 3	MW = 1.000, P = 0.001 (<0.01), Highly sig.	

Table 1 show comparison of abrasion resistance between different types of artificial acrylic denture teeth. Kruskal-Wallis test showed significant difference between the groups for abrasion resistance ($\chi^2 = 40.796$, df =5, P <0.001). After this **Mann-Whitney U** test was applied for pairwise comparison, which showed following observations:

1. Abrasion resistance values in Group 3 was significantly higher than Group 1, Group 2.
2. Abrasion resistance values in Group 4 was significantly higher than Group 1, Group 2, Group 3.

3. Abrasion resistance values in Group 2 was significantly higher than Group 1.

Table 2: Comparison of microhardness in enamel layer between different types of artificial acrylic denture teeth.

Groups	Microhardness (VHN)	
	Mean ± SD	Min-Max
Group 1 (Cavitax)	19.68± 1.91	17.20-23.40
Group 2 (Ivostar)	30.95± 1.37	28.20-33.00
Group 3 (Acryplus)	39.15± 1.15	37.60-41.00
Kruskal-Wallis test	$\chi^2 = 44.802$, df =5, P = 0.000 (<0.001) Very high significant	
Mann-Whitney U test: -		
Group 1 and Group 2	MW = 0.000, P = 0.001 (<0.01), Highly sig.	
Group 1 and Group 3	MW = 0.000, P = 0.001 (<0.01), Highly sig.	
Group 2 and Group 3	MW = 0.000, P = 0.001 (<0.01), Highly sig.	

Table 2 shows comparison of microhardness in enamel layer between different types of artificial acrylic denture teeth. Kruskal-Wallis test showed significant difference between the groups for microhardness ($\chi^2 = 44.802$, df =5, P <0.001). After this **Mann-Whitney U** test was applied for pairwise comparison, which showed following observations:

1. Microhardness values in Group 3 was significantly higher than Group 1, Group 2.
2. Microhardness values in Group 2 was significantly higher than Group 1.

DISCUSSION

In today's time, the most widely accepted and used teeth for complete denture, continue to be cross linked acrylic resin. This teeth offer the advantages of chemical bonding with denture base which creates less chances of fractures and cracks. ⁶The present study was undertaken to compare the Abrasion Resistance and Microhardness of different Artificial Acrylic teeth.

12 samples of semi anatomic teeth were taken each from (Cavitax, Ivostar, Acryplus). The Testing was done on **TABER ABRADER** at Central Institute of Plastics Engineering & Technology (CIPET), Bhopal. Wear was determined by measuring the changes of weight of the specimen.

For ease of the study and statistical analysis, the various brands were placed in different groups with Cavitax forming Group 1, Ivostar Group 2, Acryplus Group 3. The readings for each of these brands were recorded under their respective group. On the analysis, it was found that group 1 had a mean Abrasion Resistance of 0.003 ± 0.001 with Minimum been 0.002 and maximum 0.004, Group 2 had a mean Abrasion Resistance of 0.005 ± 0.001 with minimum been 0.003 and maximum 0.006, Group 3 had a mean Abrasion Resistance of 0.008 ± 0.001 with minimum been 0.006 and maximum 0.008.

Different method for micro hardness had tested over time. Brinell and Rockwell hardness test are used in conjunction with metals and alloys, Where as Vickers, Knoop and Berkovich hardness are usually measured for ceramic and Shore and Universal hardness for plastics.

In this study it was decided to use Vickers hardness test as it is simple and easier. The basic principle as with all common hardness measures is to observe the questioned materials ability to resist plastic deformation from standard sources.

The readings for each of these brands were recorded under their respective group. On the analysis, it was found that group 1 had a mean Microhardness of 19.68 ± 1.91 with Minimum been 17.20 and maximum 23.40, Group 2 had a mean Microhardness of 30.95 ± 1.37 with minimum been 28.20 and maximum 33.00, Group 3 had a mean Microhardness of 39.15 ± 1.15 with minimum been 37.60 and maximum 41.00.

Mehulic⁷ studied the method, modification and application on biomaterials so they determined the significant difference in the depth and width of wear scar on different biomaterials. **Dziab**⁸ studied an analytical description study and find out which acrylic artificial teeth actually have a standardized hardness value among 5 brands of acrylic artificial teeth. The wearing of posterior teeth is faster than the anterior teeth, which can cause prematurity of occlusion and loss of vertical dimension of occlusion. They investigated and compared weight loss and volume loss between Suranultradent, premadent and dentek, they concluded that Suranultradent has better wear resistance.⁹

CONCLUSION

- Under the prevalent experimental conditions and within limitations of this study, since the wear resistance of the 3 types of polymethylmethacrylate denture teeth was different and the following conclusion can be drawn.
- Samples taken from Group 3 (Acryplus) showed maximum Abrasion Resistance followed by Group 1 (Cavitax), Group 2 (Ivostar).
- Samples taken from Group 3 (Acryplus) showed maximum Microhardness followed by Group 1 (Cavitax), Group 2 (Ivostar).
- The study also established the fact that, the teeth set with maximum number of layers had the maximum Abrasion Resistance and Microhardness.

CONFLICTS OF INTEREST

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

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