Research Article

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Comparision of Wear Resistance of Cross Linked Acrylic Teeth with Modified Acrylic Teeth: An Invitro Study

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ABSTRACT

Background: The wear resistance of denture teeth is important for the longevity of removable prostheses of edentulous patients. Inferior wear resistance of acrylic resin artificial teeth is a significant limitation for complete denture therapy due to its inability to resist parafunctional movements and maintain proper occlusal relationships over time.

Purpose: To investigate and to compare the wear resistance of four different commercially available acrylic denture teeth using an in vitro wear testing device.

Materials and methods: Four different artificial denture teeth - Acrypan, Acryrock, Ivoclar, Bredent were tested in this study. 60 specimens (20 teeth of each type) were tested for wear resistance in terms of loss of weight and loss in volume on a wear and friction monitor for 5,000 cycle wear periods (total of 10,000 cycles) under a 0.50 kg load. The statistical analysis was done using SPSS (Statistical Package for Social Sciences) Version 20.0 statistical Analysis Software. Mean ± SD was calculated for all the values. One sample't' test was used to get the probability level and the values were represented to know their significance. The correlation coefficients between the various variables were also calculated.

Results: The result denotes that Bredent (neo.lign) teeth has improved wear resistance followed by Ivoclar , Acryrock and Acrypan.

Keywords: Wear resistance, acrylic denture teeth.

INTRODUCTION

Denture teeth are made of either Acrylic Resin or porcelain. Acrylic teeth are most widely used and preferred over porcelain teeth due to their wide range of desirable properties. Acrylic resin teeth bond well to denture base resin can be easily ground, recontoured and polished without compromising their properties, have a desirable natural feel, are less prone to fracture, do not abrade opposing natural or artificial tooth, absence of clicking sound and have a natural appearance [1]. However, acrylic resin teeth have a major drawback of low wear resistance. The factors affecting the wear rate include the pressure between the abrading surfaces, the relative speed of movement between the surfaces, the characteristics of the

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surfaces&the composition of the materials in contact. Wearing away of denture teeth will compromise both the function and the aesthetics of the denture [2].

It has been observed that, in the oral cavity posterior denture teeth wear faster than the anterior teeth, causing occlusal prematurities and loss of vertical dimension of occlusion. The loss of vertical dimension of occlusion lays more stress on the anterior alveolar ridge, which in turn increases the rate of residual ridge resorption and causes loss of alveolar ridge height in the anterior segment and compromises esthetics. Hence it is important for the clinician to choose acrylic resin teeth with high wear resistance [3]. This study is an attempt to compare the wear resistance of acrylic resin teeth manufactured by three different manufacturers.

AIMS

- To investigate wear resistance of following commercially available acrylic denture teeth. They are :

a) Acrypan
b) Acryrock
c) Ivoclar
d) Bredent

- To compare the wear resistance of the above commercially available acrylic denture teeth

MATERIALS AND METHODS

PREPARATION OF ACRYLIC ROD:

Modelling wax is used to make a wax rod of dimensions 7 mm in diameter and 35 mm in length (fig 1) .These wax rods were invested in Type III dental stone. Type III dental stone was mixed according to the manufacturer's water powder ratio and filled in one half of the complete denture flask. The wax patterns were immersed halfway into the unset dental stone (fig 2). Once the stone was set, upper half of the flask was filled with stone and the flask was closed under bench press. The flask was then dewaxed and the two halves of the flask were separated. Separating medium was applied in the mold space. Cold-cure acrylic resin was mixed. The acrylic resin was packed into the mold space in the dough stage. After the cold-cure acrylic resin was cured, the acrylic rod was retrieved (fig 3). In this manner eighty acrylic rods were prepared.

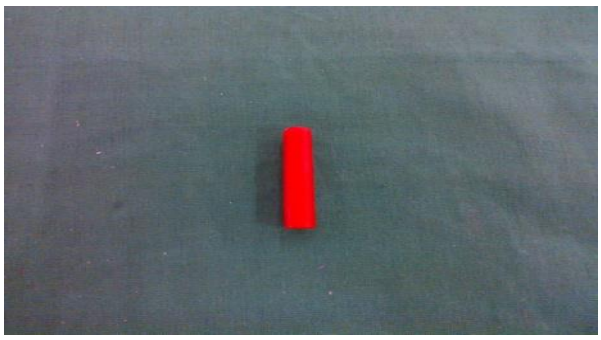

Fig 1: Wax rod

Fig 2: Flasking of wax rod.

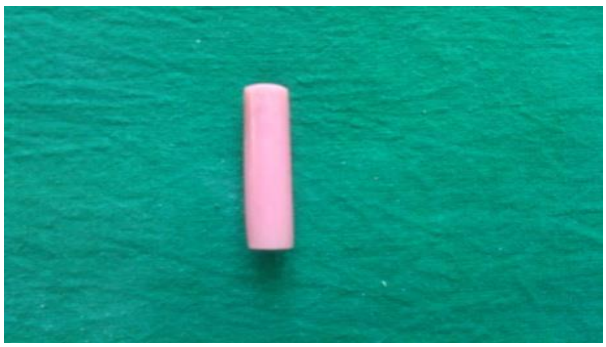

Fig 3: Acrylic rod.

PREPERATION OF TEETH SPECIMENS

A total of eighty specimens, twenty of each product is taken, using maxillary and mandibular molar teeth. The ridge lap surface of the teeth was made flat and parallel to the occlusal surface using acrylic burs. The teeth were fixed onto the prepared acrylic rods using cold cure acrylic resin. The occlusal surface of the teeth were reduced to ensure that the specimen would evenly contact the abrading surface during the test. (fig 4)

Fig 4: Arylic rod with tooth specimen

WEAR TESTING PROCEDURE:

The specimen tooth along with the attached rods were weighed. Weight of each specimen was measured using the electronic balance (Sartorius BSA 22S-CW) up to accuracy of 10^{-4} Gm, and volume of the specimen was checked using a measuring glass of 0.2cc accuracy. Wear and Tribological testing machine (Ducom TR-20LE-PHM-300) also called as Pin on Disk machine is used for testing wear of acrylic teeth. It consists of a pin holder to which the samples to be tested are attached. This pin holder hold the sample against a rotating abrasive steel disk on which the wear of the sample is carried out under specific load.(fig 5)

Fig 5: Wear testing machine

The tooth specimen which has to be tested is attached to the pin holder of the machine. A 600 grit silicone carbide paper is attached to the surface of the rotating disk(fig 6). The tooth specimen is adjusted such that the occlusal surface of tooth specimen touches the silicone carbide paper on the disk(fig 7). Dry sliding wear tests have been carried out on a pin- on - disc apparatus with an applied load of 0.5 kg . Each specimen was subjected to 5,000 cycles (300 rpm)with a sliding diameter of 70mm, after which it was removed from the testing device, cleansed of all debris and weighed in the electronic balance to weigh the difference in weight before and after 5,000 cycles. Each specimen was then replaced in the wear-testing device for another 5,000 cycles to complete 10,000 cycles needed for the study. Each specimen was abraded on a fresh silicon carbide paper to avoid clogging with wear debris as a result of multiple passes over the same abrasive surface. After 10,000 cycles the specimens were removed from the holder and the weight and volume was checked to calculate the loss of weight and volume.(fig 8)

Fig 6: 600 grit silicone carbide paper

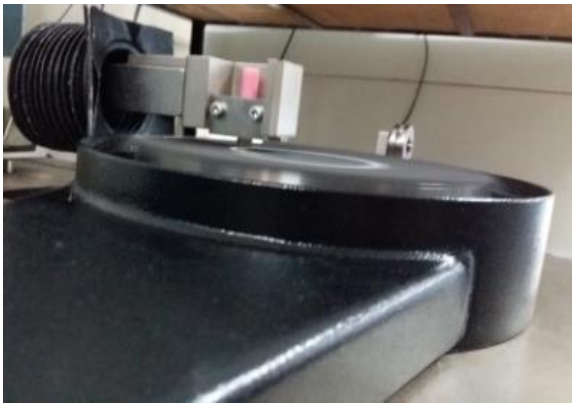

Fig 7: Grinding of specimen

Table 1: Comparison of Weight of four different materials before study.

Statistical Analysis	Groups			
	Group I (AcrypanTMXL	Group II (Acryrock)	Group III (Ivoclar)	Group IV (Neo lign/ Bredent teeth)
Mean±SD (gm)	2.38±0.032	2.29±0.071	2.22±0.057	2.19±0.000
Pearson correlation (r)	1#	-0.421##	-0.012##	-
N	20	20	20	20
Significance (p-value)	-	0.064*	0.959*	-

Table 2: Comparison of Weight of four different materials after 5,000 cycles.

Statistical Analysis	Groups			
	Group I	Group II	Group III	Group IV
Mean±SD (gm)	2.38±0.037	2.29±0.072	2.22±0.059	2.18±0.005
Pearson correlation (r)	1#	-0.442##	-0.032##	-0.065##
N	20	20	20	20
Significance (p-value)	-	0.051*	0.894**	0.786**

Table 3: Comparison of Weight of four different materials after 10,000 cycles.

Statistical Analysis	Groups			
	Group I	Group II	Group III	Group IV
Mean±SD (gm)	2.37±0.033	2.28±0.072	2.22±0.059	2.1±0.005
Pearson correlation (r)	1#	-0.446##	-0.052##	-0.169##
N	20	20	20	20
Significance (p-value)	-	0.048*	0.829**	0.475**

Table 4: Loss of volume during procedure for all the study samples of four groups.

Study Samples	Loss of Volume Measurement (gm)			
	Group I	Group II	Group III	Group IV
Mean±SD	0.10±0.000	0.10±0.000	0.10±0.000	0.10±0.000
t-test	3.619E+16	3.619E+16	3.619E+16	3.619E+16
Df	19	19	19	19
Significance (p-value)	0.000*	0.000*	0.000*	0.000*

Fig 8: Electronic weighing balance.

RESULTS

The statistical analysis of the results showed the following:

- When comparing Group1, Group 2, Group 3 , Group 4 the weight and volume before study, the weight loss after 5,000 cycles, the weight loss and volume change after 10,000 cycles, were highly significant.
- The result denotes that Bredent (neo.lign) teeth has improved wear resistance followed by Ivoclar , Acryrock and Acrypan.

DISCUSSION

Acrylic resin teeth are the most widely used denture teeth. They have the distinct advantage of adjustability, lack of clicking sounds and good bonding to denture base material when compared to porcelain teeth, but acrylic resin has the disadvantage of poor wear resistance. Posterior teeth are used for chewing and encounter increased load when compared to anterior teeth. Hence posterior acrylic denture Acrylic rods teeth tend to wear faster than the anterior acrylic denture teeth. Occlusal wear thus compromises the masticatory efficiency and also reduces the vertical dimension of occlusion [4]

Acrylic resin teeth have been modified to overcome the disadvantage of wear by using cross-linking agents, different monomers, and the addition of fillers. [5] PMMA has been reported to have advanced with the advent of cross-linked agents, which are bifunctional monomeric molecules that are added to the polymeric material to allow crossing between linear polymeric chains. The cross-linked polymer was later modified by increasing the quantity of cross-linked agents to ensure a higher degree of cross-linking between the polymers, or by blending special polymers and co-polymers. Other modification of crosslinked polymer was the appearance of resins with interpenetrating polymer network (IPN). IPN resin is formed when a polymer network is crossed inside another network occupied by a second crossed polymer. The crossed networks coexist in the same volume of the space (one being physically retained within the other) and cannot be separated without chemical bond rupture. These factors may influence the final quality for the acrylic resin and produce denture teeth with better mechanical and physical properties. [6] New types of artificial teeth using modified acrylic resin that incorporate cross-linking agents and composite resin containing filler have become increasingly common. A profoundly crosslinked system has the following advantages: color stability, plaque resistance, tissue compatibility, wear resistance, high grinding strength and excellent polishing properties (due to increased thermal resistance) Cross-linking agents also improve strength and crazing resistance. Double cross-linking procedure, eliminates the weak points of conventional polymethacrylate teeth, such as the exposure of uncross-linked polymer beads that detach during grinding. Simultaneously, the double cross-linking process leads to a considerably enhanced resistance to the mechanical wear caused by food, contact with the opposing dentition as well as tooth brushing.[1]

However, cross-linked acrylic resin artificial teeth have been reported to demonstrate lower bond strength to denture base resin when compared to conventional acrylic resin teeth[7].Therefore, the ridge lap portion of the teeth is expected to be the least cross-linked so as to facilitate bonding to the denture base resin. Hardness is considered to be related to wear resistance and is the most commonly examined mechanical property indicator for synthetic artificial tooth materials. [7]

The search for a more wear-resistant denture tooth material resulted in the development

of modified resin teeth that display acceptable wear resistance. In present days, acrylic resin denture teeth can be classified into two main categories: conventional (with crossed-linked polymeric chains) and high-strength (with various polymer technologies that provide different chemical compositions). Some studies have found a higher wear resistance for the high-strength acrylic resin denture teeth with modified polymers in comparison to conventional PMMA, while others have found no advantages of such materials with regard to wear properties .

Earlier studies [8-11] have compared wear resistance of acrylic and porcelain denture teeth and acrylic and composite denture teeth. There are very few studies, which compare the wear resistance of different acrylic denture teeth. Coffey et al. in their study tested the wear resistance of conventional acrylic resin and Interpenetrating Polymer Network reinforced acrylic resin teeth and found that Interpenetrating Polymer Network reinforcedacrylic resin teeth have higher wear resistance [12].

In the present study comparison between various crosslinked teeth and modified acrylic teeth with layered structure were made. This comparison is more valid as cross-linked teeth are the most widely used teeth for denture fabrication today and hence the clinician needs to choose among various cross-linked teeth and newly arrived modified teeth. The present study was conducted to determine the wear resistance of four commercially available cross-linked acrylic denture teeth. For this, 20 samples of semi-anatomic acrylic denture teeth of each type i.e.,acrypan (cross linked acrylic denture teeth, Ruthinium dental product),acryrock (double cross linked acrylic denture teeth , Ruthinium dental product), Blue line DCL Premium teeth(double cross linked acrylic denture teeth ,Ivoclar Vivadent), Neo.lign teeth(modified PMMA acrylic denture teeth, Bredent), were selected. . The amount of wear was determined by measuring the change in weight and volume of the specimens . The similar method was followed by Verma et al [1]. For this study ‘‘wear and friction monitor’’ was used, as the instrument allows varying loads to be applied on the test sample .In present study a standard load of 0.5kg is used during the wear cycles and the wear of acrylic teeth is done against a 600grit silicone carbide paper.

As the oral cavity displays masticatory cycles ranging 5,000–300,000 cycles in a day, to simulate this condition a wear cycle of 5,000–10,000 was selected. This was in accordance with study done by Hirano et al.[13]. Whitman et al. [3]in their study, on the measurement of wear resistance of acrylic resin denture tooth material, used specimens shaped in the form of disks. Whereas in the present study, specimens used were acrylic resin denture teeth.

Statistical analysis of obtained result showed that in Group 1(Acrypan) (mean density 0.35 ±0.006) the mean decrease in weight and volume was found to be 0.011 and 0.1, respectively. In Group 2 (Acyrock) (mean density 0.34±0.011) the mean decrease in weight and volume was found to be 0.010 and 0.1, respectively. In Group 3 (Ivoclar) (mean density 0.32±0.008) the mean decrease in weight and volume was found to be 0.006 and 0.1, respectively. In Group 4 (Bredent) (mean density 0.32±0.002) the mean decrease in weight and volume was found to be 0.005 and 0.1, respectively The result denotes that Group 4 has improved wear resistance followed by Group 3 , Group 2 and Group 1.

CONCLUSION

From the present study following conclusions can be drawn.

- When comparing Acrypan, Acryrock, Ivoclar and Bredent , the weight before study, the weight after 5,000 cycles, the weight after 10,000 cycles, the weight loss and the volume loss was significant.
- The result denotes that Bredent (neo.lign) teeth has improved wear resistance followed by Ivoclar , Acryrock and Acrypan.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

REFERENCES

1. Verma AK, Tandon BK, Agarwal NK (1985) Study of wear resistance of acrylic teeth produced in India. J Indian Dent Assoc 57:65–68

2. Khan Z, Morris JC, Von Fraunhofer JA (1984) Wear of non anatomic acrylic resin denture teeth. J Prosthet Dent 52:172–174

3. Whitman DJ, Mc Kinney JE, Hinman RW, Hesby RA, Pelleu GB (1987) In vitro wear rates of three types of commercial denture tooth materials. J Prosthet Dent 57:243–246.

4. Mallika S. Shetty , K. Kamalakanth Shenoy An in vitro analysis of wear resistance of commercially available acrylic denture teeth . J Indian Prosthodont Soc (July-Sept 2010) 10(3):149–153.

5.Powers JM, Sakaguchi RL. Craig's restorative dental materials.12th ed. Philadelphia: Mosby Elsevier; 2006. p. 544-546.

6. Klempner D. In:Klempner D, Frisch KC . Advances in Interpenetrating Polymer Networks, Volume IV. Boca Raton, FL, CRC Press, 1994, 1-290.

7.Takahashi Y, Chai J, Takahashi T, Habu T. Bond strength of denture teeth to denture base resins. Int J Prosthodont 2000;13: 59-65.

8. Ogle Re, David LJ, Ortman HR (1985) Clinical wear study of a new tooth material: Part II. J Prosthet Dent 54:67–75

9. Harrison Alan (1976) Clinical results of the measurement of occlusal wear of complete dentures. J Prosthet Dent 35:504–511

10. Von Fraunhofer JA, Razavi R, Khan Z (1988) Wear characteristics of high-strength denture teeth. J Prosthet Dent 59:173–175

11. Ogle RE, Davis EL (1998) Clinical wear study of three commercially available artificial tooth materials: thirty-six-month results. J Prosthet Dent 79:145–151

12.Coffey JP, DeLong R, Goodkind RJ, Douglas WH (1985) In vitro study of the wear characteristics of natural and artificial teeth. J Prosthet Dent 54:273–280

13.Hirano S, May KB, Wagner CW, Hacker CH (1998) In vitro wear of resin denture teeth. J Prosthet Dent 79:152–155.