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RESEARCH ARTICLE

TO COMPARE AND EVALUATE THE EFFECT OF ARTIFICIAL SALIVA ON THE FLEXURE STRENGTH OF THREE COMMERCIALLY AVAILABLE DENTURE BASE RESIN MATERIAL: AN IN VITRO COMPARISON STUDY

[1]Dr. Mukul Saxena, [2]Dr. Aarathi Shenoy, [3]Dr. Gaurav Chaudhary, [4]Dr. Niranjan Reddy [*,5]Dr. Sankalp Verma, [6]Dr. Kuber Tyagi and [7]Dr. Marilia marceliano-alves

[1]Associate Professor, Department of Dentistry, Rajshree Medical Research Institute, Rampur Road, Bareilly, UP, India
[2]Oral Maxillofacial Radiologist, Goa University, Goa, India
[3]Assistant Professor, Department of Orthodontics, Seema Dental College, Rishikesh, Uttarakhand, India
[4]Professor, Department of Oral Medicine and Radiology, Bhabha College of Dental Sciences, Bhopal, MP, India
[5]Reader, Department of Oral Medicine and Radiology, Bhabha College of Dental Sciences, Bhopal, MP, India
[6]Assistant Professor, Department of Oral Medicine and Radiology, Teerthankar Mahaveer Dental College, Moradabad, UP, India
[7]Professor of Specialization Course in Endodontics at Brazilian Dental Association - Niterói - RJ; Professor of Specialization Course in Endodontics at Santos Dumont Air Force \ Dental Clinic - Rio de Janeiro, Brazil

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ABSTRACT

Objectives: The aim of this study is to compare the effect of artificial saliva on flexural strength of three commercially available denture base acrylic resins.
Methods: In this study three commercially available heat cure denture base resins namely Trevalon, Trevalon-Hi and Pyrax Acryl-Hi were taken. The artificial saliva was prepared in one of our laboratory and the samples were immersed in artificial saliva in order to simulate oral environment. The time dependent changes in the flexural strength of acrylic resins was evaluated and compared with the samples soaked in artificial saliva.
Results: A total of 84 samples (28 samples of each type) were made. According to the mean value, the flexural strength was in following order: Trecvalon-Hi; Pyrax Acryl-Hi and Trevalon. The flexural strength decreases with time and after soaking in saliva.
Conclusion: PYRAX Acryl-Hi possesses good strength and aesthetics and offers better treatment options as the results are concerned. Since it is manufactured in India it is free from import-export charges. Hence it is relatively economical.

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INTRODUCTION

Acrylic resins were introduced in dentistry in 1937, and till date are regarded as one of the best materials to be used as denture bases for removable prosthesis. (Machado *et al*., 2007; Arnold *et al*., 2008) Denture bases are responsible for artificial tooth retention, stability and distribution of masticatory forces over a large tissue - bearing area. The heat cure denture base resins are extensively used for their properties such as ease of handling, durability and aesthetics etc.

****Corresponding author: Dr. Sankalp Verma,***
Reader, Department of Oral Medicine and Radiology, Bhabha College of Dental Sciences, Bhopal, MP, India.

The mechanical properties of denture base resins are very important for the clinical success of multiple type of prosthesis (Machado, 2007; Arnold, 2008). The strength properties of denture base acrylic resins ensure that the prosthesis serves its intended functions effectively, safely and for a reasonable period of time. Acrylic resins must be strong and resilient so as to withstand impact. Most prosthetic acrylic resins consist of polymethylmethacylate (P.M.M.A.) resin and additional copolymers. Most of the manufacturers of PMMA based denture base resins refer to their products as high strength (impact) and claim new and improved strengthening properties, yet there is little to no research to support strength differences between contemporary versions of PMMA products (Arnold,

2008; Anusavice K.Phillip's, 1996). In this study, the effect of artificial saliva on flexural strength of three commercially available heat cure acrylic resins was compared.

Aims and Objectives

- To compare the effect of artificial saliva on flexural strength of three commercially available denture base acrylic resins. (Trevalon-high strength, Pyrax Acryl-high strength and Trevalon).
- To assess the time dependent changes in the flexural strength of acrylic resins and compare it with the samples soaked in artificial saliva.
- To evaluate the microstructure of fractured acrylic resin interface by scanning electron microscope.
- To find out an economical and best acrylic for fabrication of denture base.

MATERIALS AND METHODS

In this study three commercially available heat cure denture base resins namely Trevalon, Trevalon-Hi and Pyrax Acryl-Hi were taken. The selection of materials used was based primarily on their popularity and availability in India (Arundati and Patil, 2006). These materials were selected to ensure that the results of this study would have further implicational value in the commercial dental industry when published. The artificial saliva was prepared in one of our laboratory and the samples were immersed in artificial saliva in order to simulate oral environment. The time dependent changes in the flexural strength of acrylic resins was evaluated and compared with the samples soaked in artificial saliva. A total of 84 samples were made. 28 samples of each type of acrylic resin were prepared with the dimension of 50x25x2.5mm. The samples were cured at 73^0 C for 9 hours, by the long curing cycle. The studies say that the acrylic resin material achieves its maximum strength when it is cured by long curing cycle as compared to short curing cycle (Anusavice, 1996; Preetha *et al*., 2005; Braden, 1964). The dry strength and wet strength of all these samples was evaluated which is as shown in the following tables:

The artificial saliva used in this study was a carboxymethylcellulose (CMC) based saliva (SALIVEZE). In this study the artificial saliva was prepared in department of bio-chemistry lab. The composition of saliva is as follows (Preetha *et al*., 2005; Faot, 2009). (Sodium carboxymethylcellulose 10g/l, Potassium chloride 0.62g/l, sodium chloride 0.87g/l, magnesium chloride 0.06g/l, calcium chloride 0.17g/l,potassium di hydrogen orthophosphate 0.30g/l, sodium fluoride 0.0044 g/l, sorbitol 29.95g/l, spirit of lemon 5ml, deionized water 100ml).

Flexural Strength Test

The three point bending test was performed on a Universal Testing Machine and the readings were recorded. The flexural strength test is taken in this study because a denture in function remains under tensile, compressive and shearing forces. In three point bending test all the three parameters come into play as in case of a denture in function. The prepared dry and wet acrylic resin specimens were placed (one by one) on a jig having two parallel pins, 40mm apart. The load was applied on the sample and the sample shows flexion. After reaching the maximum flexion the sample broke under load and the reading was recorded (Gurbuz *et al*., 2010; Test M604: Scanning electron microscopy).

Microstructural Analysis of the fractured surface

After the fracture of the samples, 2 fractured samples were randomly taken from all the 12 groups.(T, TH, AH, T30, TH30, AH30, T60, TH60, AH60, T90, TH90, AH90) The SEM analysis of the fractured segment was carried out in the following manner (Parrington, 2002; Materials and devices, American Dental Association, 211E Chicago Ave, Chicago, 60611). (Gurbuz *et al*., 2010; Test M604: Scanning electron microscopy) A slice of 1 cm was cut from the fractured surface. Cut section was placed on the stub. Gold-palladium coating was done. Fractured surface was analysed under scanning electron microscope. The SEM study was conducted in Department of Microscopy, College of Veterinary Sciences, Pant Nagar University, Uttarakhand (Gurbuz *et al*., 2010; Test M604: Scanning electron microscopy). (Fig.1)

Dry strength

Trevalon(t)	Trevalon-hi (th)	Acryl-hi(ah)
4 samples	4 samples	4 samples

Wet strength (30, 60 and 90 days immersion in artificial saliva)

T 30-8 Samples	TH 30-8 Samples	AH 30-8 Samples
T 60-8 Samples	TH 60-8 Samples	AH 60-8 Samples
T 90-8 Samples	T H 90-8 Samples	AH 90-8 Samples

Table 1. Flexural strength in MPa

Group	T	T 30	T 60	T 90	T H	T H 30	T H 60	T H 90	A H	A H 30	A H 60	A H 90
1	91.2	94.39	84.10	84.33	119.04	102.80	101.53	100.11	104.45	95.73	81.29	98.88
2	90.0096	93.27	68.12	80.79	96.31	121.15	67.51	86.59	110.03	92.39	92.24	77.76
3	85.5936	84.17	91.78	79.68	99.76	87.21	88.78	84.13	108.86	113.97	98.69	99.23
4	88.1664	90.36	72.27	70.85	111.55	108.48	93.04	84.29	101.15	87.01	94.62	77.84
5		94.85	60.94	83.17		99.76	98.46	85.59		88.59	73.65	85.86
6		74.30	103.64	77.88		73.50	118.04	99.11		84.79	99.65	105.83
7		78.41	91.08	79.56		74.88	65.74	91.24		88.28	96.88	85.98
8		89.40	84.06	94.39		97.88	101.49	93.43		91.24	88.01	84.94
Mean	88.7424	87.39	82.00	81.33	106.67	95.71	91.82	90.56	106.12	92.75	90.63	89.54
SD	2.44	7.69	14.07	6.66	10.52	16.39	17.73	6.48	4.10	9.22	9.15	10.48
CV	2.75	8.80	17.16	8.19	9.86	17.13	19.31	7.16	3.68	9.94	10.10	11.71

RESULTS

The flexural strength of high impact resins are significantly higher than the conventional one. The high impact acrylic resins are the economically expensive options but in terms of flexural strength they are always better than the conventional one (Gurbuz *et al*., 2010). The decreasing order of flexural strength is TH>AH>T.According to the mean value, the flexural strength of Trecvalon-Hi is the highest, followed by Pyrax Acryl-Hi and the least strength is recorded with the Trevalon. One way analysis also shows a very significant result, regarding the type of material (Fig 2).

The flexural strength for all three types T, TH and AH decreases with time.As the samples are placed in artificial saliva, it absorbs water and flexural strength decreases. The dry strength of T, TH and AH group is always more than the wet strength (Fig 3). The microstructural analysis of the fractured surface reveals that in the Trevalon group the structure becomes loose and the crack propagation become evident. The decrease in strength become evident as the time passes, due to the presence of loose but organized structure. Presence of rubber additives and micro voids in the structure of Trevalon Hi and Acryl Hi are responsible for the decrease in strength.

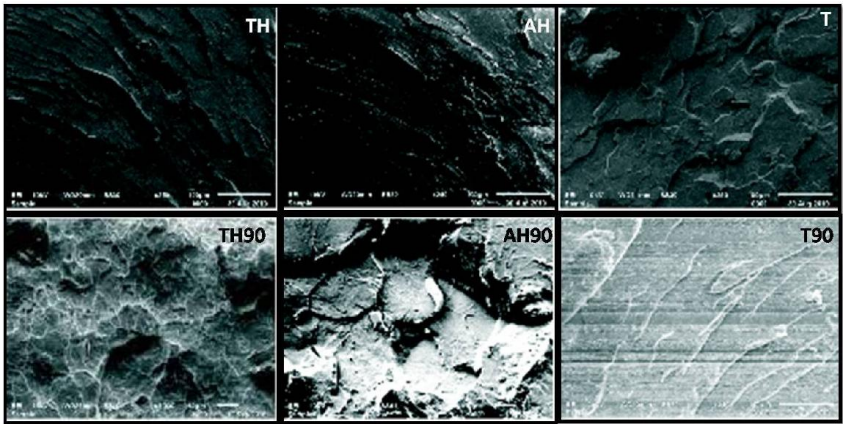
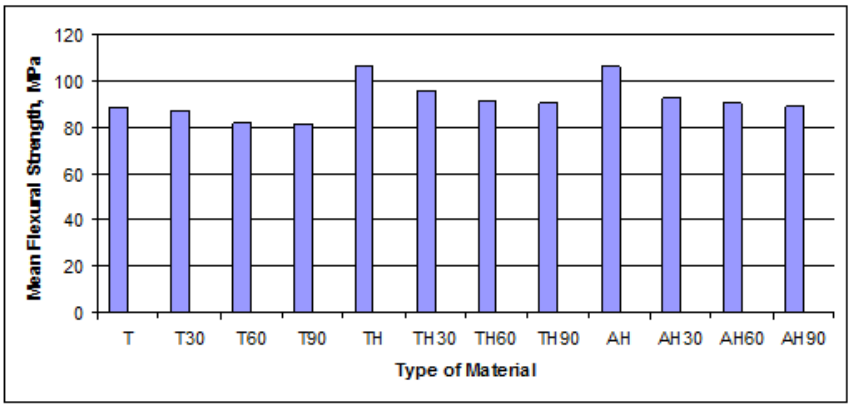
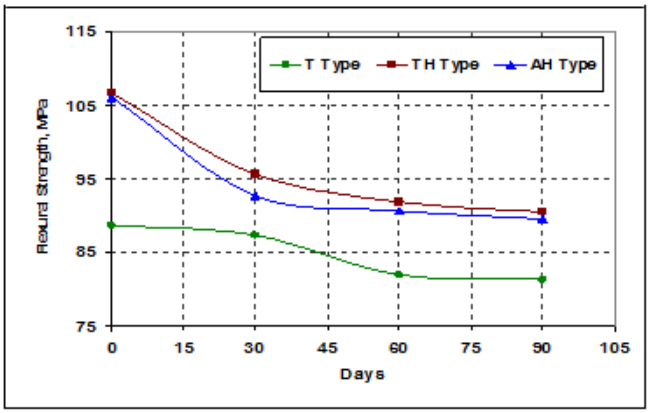


Fig. 1. Scanned electron micrograph



The bar diagram of the mean flexural strength of all the 12 groups shows that the flexural strength values of the dry samples is more as compared to the flexural strength values of the wet samples, irrespective of the type of material (Trevalon, Trevalon - Hi,Acryl – Hi)
This bar diagram also showed that the order of flexural strength is as follows :
TH >AH >T T > T30 > T60 > T90, TH > TH30 >TH60 >TH90, AH >AH30 >AH60 >AH90

Fig. 2. Mean Flexural Strength of Dry and Wet Samples of all the 12 groups



This graph shows the flexural strength of the samples decreases as the time period increases, irrespective of the type of material.

Fig. 3. Comparison of Flexural Strength, MPa all types of material with time

The water molecules occupy the spaces between the polymeric chains and the polymeric chains get apart. Water acts as a plasticizer and prevents the further polymerization, hence the strength decreases. A loose and disorganized pattern is evident in the SEM micrograph. The Trevalon – Hi shows a lamellar structure in dry conditions and when it absorbs water the fibrillar pattern comes into picture. The Acryl- Hi also shows a lamellar pattern in dry condition but after storage in water they show a disorganized, compact and fibrillar pattern of polymeric chains. The results of the SEM are also in accordance with the previous studies (Arundati and Patil, 2006; Faot, 2009).

DISCUSSION

The success of a poly (methyl methacrylate) resin denture base material significantly depends on the mechanical properties of the material. An increase of PMMA resin denture bases fracture has therefore influenced the design of this in vitro study. The objective of the experiment was to evaluate and compare the effect of artificial saliva on the flexural strength of three commercially available heat cure denture base resin material (Arundati and Patil, 2006; Faot, 2009). In general, the main findings of this study are that the flexural strengths of the high impact resin reflected a significant difference to the conventional heat cure resin. The flexural strength of all the three type of resin in dry condition is higher than the flexural strength in wet condition (Arundati and Patil, 2006). The mean flexural strength in dry condition was highest with the TH group (106.67 MPa) and the least mean flexural strength in dry condition was with the T group (88.74 MPa). The AH group (106.12 MPa) shows the intermediate strength value. In this study out of three, two denture base resins were high impact and the flexural strength of these two are higher than the conventional one. The reason behind this difference is that the manufacturers of high impact resin add rubber additives in the polymeric mass (Preetha and Banerjee, 2005). These rubber materials (styrene, butadiene) were going to make the material flexible and hence the high impact resins represent more flexion during the loading (Anusavice, 1996; Faot, 2009; Parrington, 2002). The results of this study reveal that the high impact resins are a better option than the conventional one. One way analysis of variance says that there is a extremely significant difference among the T, TH and AH group (P = 0.0001). So, the results are statistically significant. The results of the study are in accordance to the other studies conducted (Gurbuz *et al*., 2010; Braden, 1964).

The flexural strength of the wet samples also decreases with time.A person wears prosthesis for 16 to 18 hours per day. Human saliva consists of 99.5% of water and 0.5% of solids. So, the prosthesis remains in contact with saliva for this period of time. The introduction of water molecules within the polymerized mass reduces the strength of acrylic resins (Arnold, 2008; Arundati and Patil, 2006). Poly-methyl methacrylate absorbs water in a relatively small amount when placed in an aqueous medium. The water exerts significant effects on the mechanical properties and dimensional properties of acrylic resins. Water molecule penetrate the polymethylmethacylate mass and occupy positions between polymer chains (Anusavice, 1996). Consequently, the affected polymer chains are forced apart.

The introduction of water molecules within the polymerized mass produces two important effects. First it causes a slight expansion of the polymerized mass. Second, water molecules interfere with the entanglement of polymer chains and thereby act as plasticizers (Anusavice, 1996). The introduction of water molecules within the polymerized mass reduces the strength of acrylic resins. The water acts as a plasticizer and reduces the mechanical properties such as hardness, transverse strength, impact strength and fatigue limit of the acrylic resin (Arundati and Patil, 2006; Preetha and Banerjee, 2005). The results of this study say that the flexural strength of the acrylic resin decreases as the time period of immersion in saliva increases (Faot, 2009). In the visual analysis of the fracture surface it is found that 80% fractures of the high impact resins are ductile while only 20% are of brittle type. While in case of Trevalon the condition is reverse that is 80 – 85% fractures show the brittle behavior and the rest 15-20% show ductile nature. The visual examination of the fracture surface of brittle type show a sharp, straight and smooth fracture line while the fracture surface of ductile type show a oblique and roughened fracture line (Faot, 2009; Gurbuz *et al*., 2010). The SEM picture of the fractured surface of Trevalon shows a stepped pattern and a granular structure. While the fracture surface of the TH group and AH group show a lamellar pattern

Summary

In this study flexural strength of three commercially available denture base resins had been compared, out of which two are high impact and one is the conventional one. The time dependant effects of artificial saliva on the flexural strength of denture base acrylic resin were also evaluated.

Conclusion

The high impact resins are a better option due to their higher strength properties, but they are the expensive options. Now the Indian brands (PYRAX Acryl-Hi) are available in the market which are equally good in strength and aesthetics. They are comparatively cheaper options as they are manufactured in India so they are free from import-export charges. Hence are relatively economical and better treatment options as the results are concerned. The time dependant changes in the acrylic resin would need a further research for a longer duration as some samples show an increased strength after the immersion in artificial saliva.

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Test M604: *Scanning electron microscopy*

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