**Journal of Advanced Medical and Dental Sciences Research**
@Society of Scientific Research and Studies

Journal home page: **www.jamdsr.com** doi: 10.21276/jamdsr ICV 2018= 82.06

(e) ISSN Online: 2321-9599; (p) ISSN Print: 2348-6805

# Original Research

## Abrasion Resistance and Microhardness of Six Artificial Acrylic Teeth- An In vitro Study

[1]Shweta Parmar, [2]Purushotam Kumar, [3]Siddharth Gupta, [4]Ambika Shrivastava, [5]G. S. Chandu, [6]Amanmeet Singh

[1]Sr Lecturer Department of prosthodontics, Rishiraj college of dental science & Research Center, Bhopal, Madhya pradesh, India;
[2]Consultant prosthodontist and Implantologist, Motihari, Bihar, India;
[3]Professor Department of prosthodontics, Rishiraj college of dental science & Research Center, Bhopal, Madhya pradesh, India;
[4]Professor Department of prosthodontics, Rishiraj college of dental science & Research Center, Bhopal, Madhya pradesh, India;
[5]Professor and head Department of prosthodontics, Rishiraj college of dental science & Research Center, Bhopal, Madhya Pradesh, India;
[6]P G student Department of prosthodontics, Rishiraj college of dental science & Research Center, Bhopal, Madhya Pradesh, India.

***ABSTRACT:***
**Background & objective:** To evaluate and compare the Abrasion Resistance and Microhardness of six different types of commercially available Artificial Acrylic teeth (Cavitax, Ivostar, Acryplus, Biorock, Cosmo, and Premadent. **Methodology:** 12 samples of each brand were evaluated for Abrasion Resistance employing Taber abrader testing Machine and for Microhardness Vickers hardness tester were used. After statistical Analysis Mann-Whitney U test was used. **Results:** Abrasion resistance values in Group 3was significantly higher than Group 1, Group 2, Group 4, Group 5 and Group 6. Abrasion resistance values in Group 4was significantly higher than Group 1, Group 2, Group3, Group 5 and Group 6. Microhardness values in Group 3was significantly higher than Group 1, Group 2, Group 4, Group 5 and Group 6. Microhardness values in Group 4 was significantly higher than Group 1, Group 2, Group 5 and Group 6.Microhardness values in Group 2was significantly higher than Group 1, Group 5 and Group 6. **Conclusion:** It was found that all of the samples tested Group 3(Acryplus) had the maximum surface Abrasion Resistance and Microhardness value.
**Key words-** Denture, Acrylic, Abrasive Resistance, Microhardness.

Received: 23 August, 2019 Revised: 19 October, 2019 Accepted: 23 October, 2019

**Corresponding author:** Dr. Shweta Parmar, Sr Lecturer Department of prosthodontics, Rishiraj college of dental science & Research Center, Bhopal, Madhya pradesh, India

**This article may be cited as:** Parmar S, Kumar P, Gupta S, Shrivastava A, Chandu GS, Singh A. Abrasion Resistance and Microhardness of Six Artificial Acrylic Teeth- An In vitro Study. J Adv Med Dent Scie Res 2019;7(11):194-200.

### INTRODUCTION

Since time immemorial humans have always been on a mission to replace the missing teeth. This quest for replacement of missing teeth has pushed us to use the prevailing science of current times and creativity to its limit. The earliest known attempts to replace missing teeth was made as early in 700BC, that time Etruscan from Northern Italy used human or animal teeth, although they distorted quickly[1.]. The first attempt to make dentures which are comparable to the current times was done in 1850's by Nelson Gogyer 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 lodgment, it had lack of translucency leading to poor esthetics and were relatively unhygienic[1.]

It was only in 1937 when Dr. Walter Wright introduced resin-'Polymethyl methacrylate' to dentistry. Polymethyl methacrylate 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 20$^{th}$century.[2] Historically porcelain teeth has been reported to be most durable teeth with least wear but Acrylic teeth are still the most commonly used, this is primarily due to their property of clinical bonding with denture base and ease of lab and clinical use[1.] With the development of technology in the field of acrylic resin efforts, were been made to mimic the natural teeth and so multi-layered cross linked acrylic teeth with enamel and dentin layers were introduced. During clinical use the outer most layer of this composite teeth is lost due to masticatory wear or occlusal adjustment which leads to exposure of layers .[3.]

Over the years acrylic teeth has 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 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.[4-5] Abrasion is wearingdown, 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. There was adirt 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 following artificial acrylic teeth Cavitax (india), Ivostar (Ivaclar, vivodent, Liechtenslein,USA), Acryplus (Ruthinum, Italy) , Biorock (Brulon, Deccan), cosmo HXL (Dentsply, Brazil), Premadent (India).[2]

## METHODOLOGY

**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.

For the study six different brands of ISO approved cross linked denture teeth were used Cavitax (India), Ivostar (Ivaclar, vivodent, Liechtenslein, USA), Acryplus (Ruthinum, Italy),Biorock (Brulon, Deccan),Cosmo (Dentsply, Brazil), Premadent (India)

**Grouping of specimen**

| For Abrasion Resistance | For Microhardness |
|---|---|
| Group 1(Cavitax)n=12 | Group (Cavitax)n=12 |
| Group 2(Ivostar) n=12 | Group 2(Ivostar)n=12 |
| Group (Acryplus)n=12 | Group 3(Acryplus)n=12 |
| Group 4(Biorock)n=12 | Group 4(Biorock) n=12 |
| Group 5(Cosmo) n=12 | Group 5(Cosmo) n=12 |
| Group6(Premadent) n=12 | Group 6 (Premadent) 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. The samples were tested on Taber abrader testing machine (5131). Total 72 samples tested on this machine. 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[14].

The samples were tested on Vickers Hardness testing machine (Leica Germany).Total 72 samples tested on this machine. 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 of each brand were sectioned to make 72specimen, the teeth were sectioned buccopalataly at the centre of the crown with low speed diamond disk (contene).Only one half of the crown were used and another were discarded. The cut surfaces were polished by silicon carbide paper (80 grit).

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. Digital stereo microscope**


**Fig 2. Camera**

**Fig 3. Vickers hardness testing machine**

**Fig 4. Diamond disc (Thickness0.25mm)**

**Glass Plates**

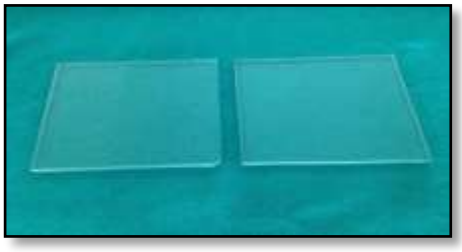

**Fig 5. Two glass pla**

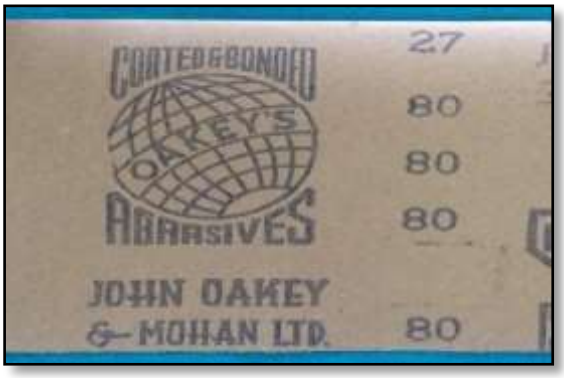


**Fig 6. Silicon carbide paper**

**Fig 7. Micromotor with hand piece**

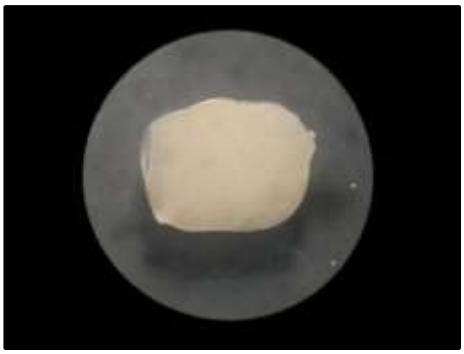

**Fig 8. Cross section of Acrylic teeth**

**Fig 9. Metallic cylinder**

**Fig 10. Taber abrader**


**Fig 11 Weighing machine**

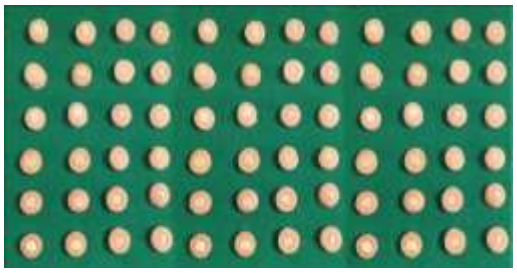

**Fig 12. 48 Samples of six groups**

**Fig 13 samples were stored in distilled water for 24 hrs. to allow water absorption.**

**Fig 14.Testing for Abrasion Resistance**

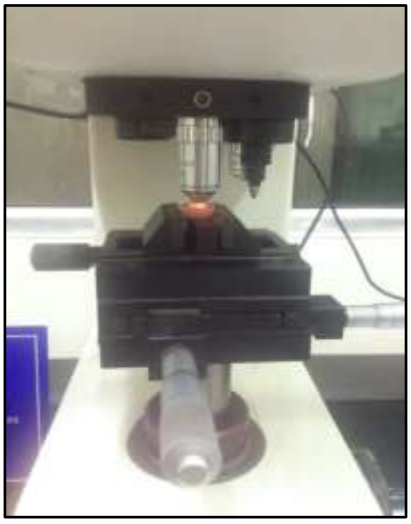

**Fig 15.Testing for Microhardness**

Table 1 shows comparison of abrasion resistance between different types ofartificial acrylic denture teeth. Mean ± SD of abrasion resistance in Cavitax, Ivostar, Acryplus, Biorock, Cosmo and Premadent groups were 0.003 ± 0.001, 0.005 ± 0.001, 0.008 ± 0.001, 0.006 ± 0.001, 0.004 ± 0.001 and 0.001 ± 0.000 respectively. Minimum and maximum values of abrasion resistance in Cavitax were 0.002and 0.004, in Ivostar were 0.003and 0.006, in Acryplus were 0.006and 0.008, in Biorock were 0.004and 0.008, in Cosmo were 0.002and 0.005 and; in Premadent were 0.001and 0.002.

## RESULTS

**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 |
| Group 4 (Biorock) | 0.006± 0.001 | 0.004-0.008 |
| Group 5 (Cosmo) | 0.004± 0.001 | 0.002-0.005 |
| Group 6 (Premadent) | 0.001± 0.000 | 0.001-0.002 |
| **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 1 and Group 4 | MW = 0.500, P = 0.001 (<0.01), Highly sig. | |
| Group 1 and Group 5 | MW = 14.000, P = 0.048 (<0.05), Sig. | |
| Group 1 and Group 6 | MW = 2.000, P = 0.001 (<0.01), Highly sig. | |
| Group 2 and Group 3 | MW = 1.000, P = 0.001 (<0.01), Highly sig. | |
| Group 2 and Group 4 | MW = 9.000, P = 0.013 (<0.05), Sig. | |
| Group 2 and Group 5 | MW = 17.000, P = 0.100 (>0.05), Not sig. | |
| Group 2 and Group 6 | MW = 0.000, P = 0.000 (<0.001)Very high sig. | |
| Group 3 and Group 4 | MW = 11.000, P = 0.019 (<0.05), Sig. | |
| Group 3 and Group 5 | MW = 0.000, P = 0.000 (<0.001)Very high sig. | |
| Group 3 and Group 6 | MW = 0.000, P = 0.000 (<0.001)Very high sig. | |
| Group 4 and Group 5 | MW = 4.000, P = 0.003 (<0.01), Highly sig. | |
| Group 4 and Group 6 | MW = 0.000, P = 0.000 (<0.001)Very high sig. | |
| Group 5 and Group 6 | MW = 1.000, P = 0.001 (<0.01), Highly sig. | |

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 3was significantly higher than Group 1, Group 2, Group 4, Group 5 and Group 6.
2. Abrasion resistance values in Group 4was significantly higher than Group 1, Group 2, Group3, Group 5 and Group 6.
3. Abrasion resistance values in Group 2 and Group 5 was significantly higher than Group 1and Group 6.
4. There was no significant difference between Group 2 and Group 5
5. Abrasion resistance values in Group 1was significantly higher than Group 6.

Table 2 shows comparison of microhardness in enamel layer between different types of artificial acrylic denture teeth.Mean ± SD of microhardness in Cavitax, Ivostar, Acryplus, Biorock, Cosmo and Premadent groups were 19.68 ± 1.91 VHN, 30.95 ± 1.37 VHN, 39.15 ± 1.15 VHN, 33.98 ± 1.68 VHN, 24.33 ± 1.50 VHN and 15.70 ± 1.98 VHN, respectively. Minimum and maximum values of microhardness in Cavitax were 17.20VHN and 23.40 VHN, in Ivostar were 28.20VHN and 33.00 VHN, in Acryplus were 37.60VHN and 41.00 VHN, in Biorock were 30.60VHN and 36.70 VHN, in Cosmo were 22.60VHN and 27.10VHN and; in Premadent were 13.10VHN and 19.30VHN. 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 3was significantly higher than Group 1, Group 2, Group 4, Group 5 and Group 6.
2. Microhardness values in Group 4 was significantly higher than Group 1, Group 2, Group 5 and Group 6.
3. Microhardness values in Group 2was significantly higher than Group 1, Group 5 and Group 6.
4. Microhardness values in Group 5 was significantly higher than Group 1 and Group 6.
5. Microhardness values in Group 1was significantly higher than Group 6.

**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 |
| Group 4 (Biorock) | 33.98± 1.68 | 30.60-36.70 |
| Group 5 (Cosmo) | 24.33± 1.50 | 22.60-27.10 |
| Group 6 (Premadent) | 15.70± 1.98 | 13.10-19.30 |
| **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 1 and Group 4 | MW = 0.000, P = 0.001 (<0.01), Highly sig. | |
| Group 1 and Group 5 | MW = 3.000, P = 0.002 (<0.01), Highly sig. | |
| Group 1 and Group 6 | MW = 3.000, P = 0.002 (<0.01), Highly sig. | |
| Group 2 and Group 3 | MW = 0.000, P = 0.001 (<0.01), Highly sig. | |
| Group 2 and Group 4 | MW = 6.000, P = 0.006 (<0.01), Highly sig. | |
| Group 2 and Group 5 | MW = 0.000, P = 0.001 (<0.01), Highly sig. | |
| Group 2 and Group 6 | MW = 0.000, P = 0.001 (<0.01), Highly sig. | |
| Group 3 and Group 4 | MW = 0.000, P = 0.001 (<0.01), Highly sig. | |
| Group 3 and Group 5 | MW = 0.000, P = 0.001 (<0.01), Highly sig. | |
| Group 3 and Group 6 | MW = 0.000, P = 0.001 (<0.01), Highly sig. | |
| Group 4 and Group 5 | MW = 0.000, P = 0.001 (<0.01), Highly sig. | |
| Group 4 and Group 6 | MW = 0.000, P = 0.001 (<0.01), Highly sig. | |
| Group 5 and Group 6 | MW = 0.000, P = 0.001 (<0.01), Highly sig. | |

## 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. Acrylic resin teeth are known for one major disadvantages, which is of for poor wear resistance.[6-7] This problem is more compounded for posterior teeth than anterior teeth. The current dental market is full of cross linked acrylic teeth of different companies with claim of superiority over one another. The present study was undertaken to compare the Abrasion Resistance and Microhardness of six different Artificial Acrylic teeth. Another parameter for testing wear is **Microhardness.** It has also found in previous study that microhardness is dependent on the number of layers. It was therefore one of the objective of the study to compare and evaluate the role of number of layers in different types of Artificial Acrylic teeth. 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.

**Acryplus-**

1) Acrylic teeth in Polymethylmethacrylate released in multilayer chromatic.

This type of tooth has important characteristics:

2) 4 Layered

3) Higher abrasion resistance and hardness

4)Colour stability;

5)Acryplus Available Range of 19 shades

**Biorock-**

1) Versatile on all aspect of denture prosthesis.
2) Impresses with its lifelike aesthetical effect due to superimposition of the dentine & enamel.
3) The subtle surface texture makes it truly a lifelike tooth moulds with perfect shape.
4) Integrated with luminescent & fluorescent effect.
5) Made for rock solid dentures with best cost efficiency.

**Premadent**

1. Enamel tended to fracture earlier due to consisting of two layers.
2. The Indian market is flooded of different brands of Acrylic resin teeth, these Acrylic resin teeth are from National and International manufacturer. Each manufacturer claims to have the best teeth set available with prize ranging from Rupees 20 to 2000.

The past studies show conflicting results which may be due to different experimental design and parameters. It was there for the intention of the study evaluates both the surface hardness and microhardness by using most widely accepted testing patterns.

It was also made sure to select six most commonly used but **ISO** certified teeth. After considering the results and reviewing the literature, it can be said that besides the chemical composition and number of layers. Several other factors have also to be considered while investigating the abrasive process to allow better scientific rationale.

These factors include the frequency of teeth coming in contacts(functional and parafunctional),intensity of occlusal forces, the type of forces on acrylic teeth(Fixed and Removable)surfaces against teeth being used(metallic and ceramic bridge)[8-9] and finally the types of abrasive cleansers being used on the complete denture. It is necessary for the dentist to select the best brand possible after their consideration to above factors. These procedures will ensure not only the longevity of complete denture but also ensure that the prime objectives of comfort zone and aesthetic can be achieved and maintain a long period of time. [10-11]

## CONCLUSION

- Under the prevalent experimental conditions and within limitations of this study, since the wear resistance of the six types of polymethyl methacrylate 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), Group 4(Biorock) Group 5(Cosmo) with least Abrasion Resistance in Group 6 (Premadent).
- Samples taken from Group 3 (Acryplus) showed maximum Microhardness followed by Group 1 (Cavitax), Group 2 (Ivostar), Group4 (Biorock) Group 5 (Cosmo) with lowest Microhardness in Group 6 (Premadent).
- The study also established the fact that, the teeth set with maximum number of layers had the maximum Abrasion Resistance and Microhardness.

## BIBLIOGRAPHY


1. Khindria S K, Mittal S, Sukhija U. Evolution of denture base materials.Journal of Indian Prosthodontic Society.2018; 13(9):p64-9.
2. Shetty M.S.,ShenoyK.K. An invitro analysis of wear resistance of commercially available acrylic denture teeth.Journal of indian prosthodontics society2010;10(3):p149-153.
3. Yuzugullu B.,Acar, O.,Cetinsahin C.,Celik C.Effect of different denture cleansers on surface roughness and microhardness of artificial denture teeth. Journal of Advance Prosthodontics.2016 Oct; 8(5): p333–338.
4. Khan Z., Morris JC et al An invitro analysis of wear resistance of commercially available acrylic denture teeth. Journal of Indian prosthodontics society2010; 10(3):p149-153.
5. Fraunhofer V., J.A.Wear characteristics of high-strength denture teeth. Journal of Prosthodontic society. 1988; p173-176.
6. HiranoS.May K.B. et al. In vitro wear of resin denture teeth. Journal of prosthetic dentistry. Journal of prosthetic dentistry 1998;79(2):p152-155.
7. HanelS.,Behr M.et al.Two body wear of artificial acrylic and composite resin teeth in relation to antagonist material.Journal of Prosth dent.2009;101(4):p269-78.
8. Mallika S..,ShenoyK.K.Aninvitro analysis of wear resistance of commercially available acrylic denture teeth.Journal of indian prosthodontics society2010;10(3):p149
9. Tamaki R., Iegami CM et al Transverse microhardness of artificial teeth Department of Prosthodontics, School of Dentistry, University Brazil ,2015; 21 (4): p204- 210
10. Savabi O., NejatidaneshF., Evaluation of hardness and wear resistance of interim restorative materials.Dental research journal2013 Mar-Apr; 10(2): p184–189.
11. Digholkar S.,Madhav V.N.V et al, Evaluation of the flexural strength and microhardness of provisional crown and bridge materials fabricated by different methods. Journal of Indian prosthodontics society 2016;16 (4)p328-334