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Effect of Denture Cleansers on Color Stability and Flexural Strength of Heat Polymerized Acrylic Resin an In-Vitro Study

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Abstract **Original Research Article**

Heat polymerized poly methyl methacrylate is the most commonly used denture base material. Selecting a denture cleanser, compatibility between various type of denture base material and cleanser must be considered to avoid harmful effects. Study objective was to evaluate the changes in flexural strength and colour change of heat cured denture base resins when treated using denture cleansers. ***Method:*** The disk shaped specimens15mm in diameter and 4mm in thickness and rectangular shaped specimens 65mm x 10mm x 3.3mm were fabricated using split mould technique. A total of 60 standardized specimens were fabricated and stored in distilled water for 24hrs. After 1 day, the specimens were appropriately labelled and immersed in groups of 20 to prepared denture cleanser solutions for treatment. Solutions were prepared and immersed according to manufactures instructions (Corega tab: one tablet to 200ml of water and immersion time is 15min; Fitty dent: one tablet to 200ml of water and immersion time is 30min). After immersion, the resin specimens will be removed, thoroughly cleanedunder running water, dried with absorbent paper, and then the procedure of immersion will be repeated. This procedure will be performed for a total of 30 times over a period of 6 days simulating patients180 days of cleansing. 10 specimens of each group where tested for flexural strength using universal testing machine. Specimens were loaded until fracture occurred. The peak load was recorded in Newton and the flexural strength was calculated from peak load and another 10 specimens were tested for colour change using spectrophotometer .The specimens were tested on the measuring head of the spectrophotometer. The colour characteristics, tristimulus values X, Y, Z, and CIE (Lab) of specimens, were evaluated. The findings were statistically analysed using ONE -WAY ANOVA and students T test. ***Results:*** Heat cure denture base resin used for this study showed significant difference in flexural strength and colour change after immersion in denture cleansers solutions when compared to control group. ***Conclusion*:** Within the limitations of the study it can be concluded that, the Corega tab and Fitty dent showed decrease in flexural strength and increase colour changes of heat cure denture base resin when compared to the control group. Hence denture cleansers should be used once a day after brushing with caution. It is advisable for patient to follow the manufacturer's instructions.

Keywords: Denture cleanser,Denture base resins, Flexural strength, Colour stability.

INTRODUCTION

Every surface of the oral cavity, natural or synthetic, becomes covered with a 0.5-1.5 µ-thick precipitate of salivary glycoprotein and immunoglobulin that is termed "pellicle within 30 minutes." The pellicle in turn provides a substrate to which oral debris and microorganismsreadily adhere [1].

Beyond the concern for esthetics, the lack of adequate denture hygiene can accumulate biofilm causing oral infections such as denture stomatitis. It is a common infection characterized by inflammation of

oral tissues and colonization on surfaces of the prosthesis by micro-organisms [2].

Mechanical methods are commonly used and are effective procedures for biofilm removal. The use of chemical cleansers is usually associated with mechanical methods, and their efficacy in removing stains and reducing biofilm formation on the surface irregularities of dentures have been reported [2].

METHODOLOGY

This vitro study was conducted in Department of Prosthodontics, Crown andBridge Including Implantologyat Al-Badar Rural Dental College and Hospital, Gulbarga, Karnataka, forevaluation of the effect of denture cleansers on colour stability and flexural strength ofheat polymerized acrylic resin.

The disk shaped wax pattern measuring 15mm in diameter and 4mm in thickness and rectangular shaped wax pattern measuring 65mm x 10mm x 3.3mm were invested in dental flask in type IV dental stone to prepare moulds using split mould technique. This technique facilitated easy removal of the wax pattern. After the setting of the stone, the flask halves were separated and the wax was removed from investment and the stone mould was cleansed leaving a rectangular and disk shaped space measuring 65mm x 10mm x 3.3mm and 15mm in diameter and 4mm in thickness respectively.

Two coats of a separating medium were applied to both dental stone surfaces. Thirty specimens of each size were prepared from heat-polymerized acrylic resin (Trevalon-HI; Dentsply Ind.). The resin was manipulated, packed and pressed into the mould according to the manufacturer's instructions. The polymerization was done in accordance complying with the manufacturer's instructions.

The method was boiling sufficient water to cover the clamped flask, remove from heat and place the flask into the water. Add 200ml cold water for every 2 litres of water used and leave for 60 minutes. Apply low heat to maintain temperature of water at about 68°C for 30 minutes, bring to boil in not less than 10 minutes and boil for further 20 minutes. All flasks were allowed to cool to room temperature before opening.

After polymerization of the resin, the specimens were removed from the molds and immersed in distilled water at 37 +1 0C for 50 +2 hours for residual monomer elimination The excess resin was trimmed with a tungsten carbide bur using a hand piece at low speed. One of the surfaces was finished using 3M-P150 sandpaper and polished on wet rag wheel with slurry of pumice. A total of 60 samples were made with 30 disks shaped and 30 rectangular shaped respectively.

The samples were divided into 3 groups of 20 specimens each containing 10 disks shaped and 10 rectangular shaped respectively. Group I: Control group i.e. distilled water, Group II: Corega tabs (GSK Mfd by Stafford Miller-Ireland), Group III: Fitty dent (Dr Reddy's laboratory LTD. INDIA).

The specimens were immersed in two denture cleansing tablets and one distilled water as control group. The 20 specimens of each group are immersed at the same time in the container, ensuring that the solution covered all specimens.

The denture cleansers were prepared as per the manufacturer's directions; 200ml of warm water (40°C) one tablet was added. The immersion time was 15mins for Corega tabs and 30mins for Fitty Dent.

After immersion, the resin specimens were removed, thoroughly washed in tap water, completely dried with absorbent paper, and then the procedure of immersion was repeated.

Thirty immersions were performed over a period of one week, simulating 180 days of cleansing by the patient. Between the soaking procedures the specimens are kept in distilled water, at room temperature, as the control group.

RESULTS

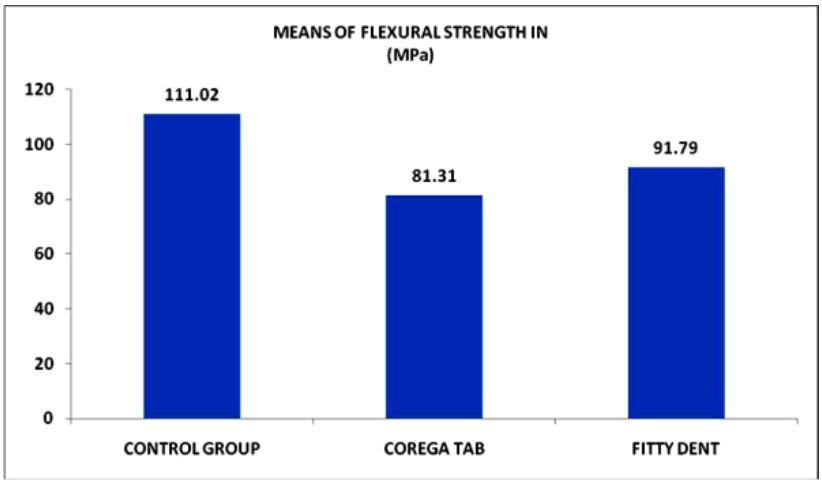
Table 1: Showing master chart of flexural strength of all denture base resin specimens Immersed in Corega tab, Fitty dent compared to control group

FLEXURAL STRENGTH (MPa)

Specimen no:	Control group	Corega	tab Fitty dent
1	102.31	78.67	**90.64**
2	111.24	94.37	**102.51**
3	122.91	98.39	**93.78**
4	104.47	90.25	**84.46**
5	121.49	88.09	**78.38**
6	123.31	66.21	**89.27**
7	101.04	64.25	**95.05**
8	90.25	85.64	**88.29**
9	121.15	75.73	**102.9**
10	**112.03**	**71.51**	**92.7**

Table II: Mean and standard deviation (SD) of flexural strength. Comparison between three group by one way Anvoa (f value)

	CONTROL GROUP	COREGA	TAB FITTY DENT
MEAN	111.02	81.31	91.79
SD	10.75	11.23	7.12
F VALUE	20.97>3.35 (FOR P=0.05), Shows Significant Difference		



Graph 1: Showing means of flexural strength in (MPa)

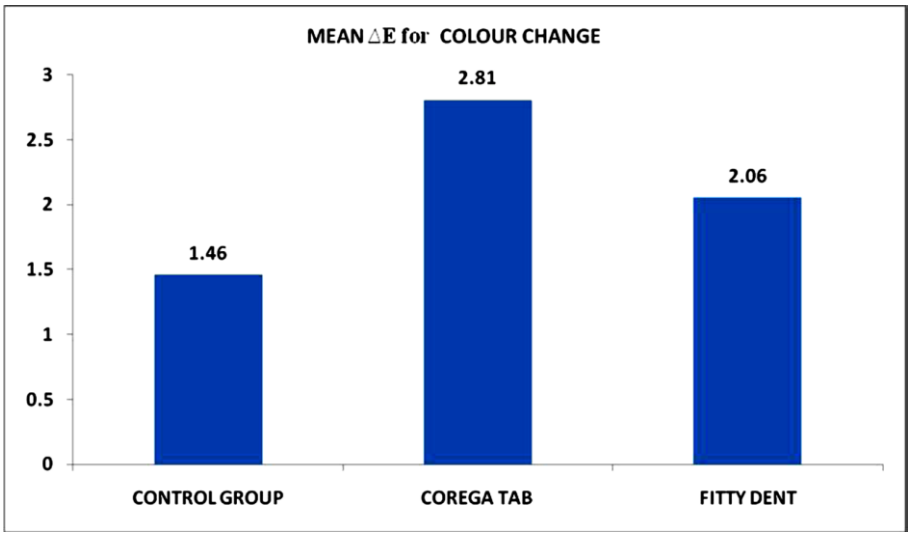
Table III: Comparison of flexural strength between two groups by student's t test

Comparison Between	T Value	Remark
Control group and corega tab	5.73	S
Control group and fitty dent	4.47	S
Corega tab and fitty dent	2.37	S

Conclusion: S:T value>1.73 (for p=0.05), shows significant difference

Table IV: Mean and standard deviation (SD) of colour change. Comparison between three group by one way anvoa (f-value)

	Control Group	Corega Tab	Fitty Dent
Mean	1.46	2.81	2.06
Sd	0.13	0.70	1.01
F Value	8.03>3.35 (For P=0.05), Shows Significant Difference		



Graph 2: Mean - E for colour change

Table V: Comparison of colour change between two groups by student's t test

Comparison Between	T Value	Remark
Control Group And Corega Tab	5.67	S
Control Group And Fitty Dent	1.74	S
Corega Tab And Fitty Dent	1.84	S

Conclusion: S: T value>1.73(For P=0.05), Shows Significant Difference
*S= Significant

The data were subjected to measure analysis of variance (one way Anvoa) and student's t test for statistical analysis.The standard deviation for control group, corega tab and fitty dent are 10.75, 11.23 & 7.12 respectively. Comparison of flexural strength between two groups by student's T test between control group & corega tab, control group & fitty dent, corega tab & fitty dent, the "T "value are 5.73,4.47 & 2.37 respectively. Comparison of colour change between two groups by student's T test between control group and corega tab, control group and fitty dent, corega tab and fitty dent, the "T" values are 5.67, 1.74, and 1.84 respectively.

Results of the present study showed that flexural strength and colour stability of the denture base resin significantly decreased after immersion in denture cleanser solutions Corega tab and Fitty dent when compared to the control group. It may be assumed that the chemical interactions of denture cleanser with methyl methacrylate have an influence on the flexural and colour stability of denture base resins.

DISCUSSION

Flexural strength and colour stability

A common problem that occurs with removable dentures is fracture. This may be due to repeated masticatory forces, accidental dropping and areas of stress concentrations due to parafunctional activities.

The ultimate flexural strength of a material reflects its potential to resist catastrophic failure under flexural load. High flexural strength is crucial to denture wearing success, as alveolar resorption is a gradual, irregular process that leaves tissue borne prosthesis unevenly supported.

As a foundation, the acrylic material should exhibit a high proportional limit to resist plastic deformation and also exhibit fatigue resistance to endure repeated masticatory loads. An acrylic resin capable of sustaining higher flexure in combination with high resistance to cyclic loading may be less prone to clinical fracture. The overall longevity of a dental prosthesis depends on physical properties and that the denture base resins may fail clinically due to flexural fatigue, low impact strength and colour stability [3].

The assessment of flexural strength and colour stability of acrylic resins has been reported as a reliable method to estimate resin behaviour under experimental conditions [2].

Hence this study was carried out to evaluate and compare the influence of denture cleansers on the flexural strength and colour stability of heat cured acrylic resins.

In this present study, the flexural strength and colour stability of heat cure denture base resins were evaluated and compared after immersing them into two types of commercially available denture cleansers. The findings for all the groups were tabulated and statistically analysed using one way ANOVA followed by student T test for intergroup comparison.

Flexural strength

It is essentially a strength test of a bar supported at each end, or a thin disk supported along a lower support circle, under a static load. It is a measure of stiffness and resistance to fracture. Flexural strength (S) was measured using a three-point bending test in a universal testing machine. The flexural strength of each rectangular specimen was calculated from the following equation.

$S = 3PL/ 2bd2$

Where
P= fracture load
L= the distance between the supports (50mm)
b= specimen width (10 mm)
d=specimen thickness (3.3 mm).

The flexural strength values were obtained in Kg/mm2, which were converted into megapascals (Mpa) (system international unit) by multiplying with 9.81N. Force in Kg/mm2x9.81=Mpa. As seen from table 1 to 3 and graph 1 shows, the control group (n=10) consisting of denture base acrylic specimens immersed in distilled water (65×10×3.3 mm), had flexural strengths ranging from a minimum of 90.25 Mpa to maximum of 123.31Mpa, with a mean value of 111.02 Mpa (SD=11.33). The mean flexural strength of denture base acrylic specimens after immersion in denture cleansers ranged from a minimum of 64.24Mpa, to a maximum of 102.9 Mpa. When compared with PMMA specimens immersed in denture cleanser solutions flexural strength of the latter groups was found to be significantly lesser ($p<0.01$) to the control group.

This indicates that immersion of acrylic denture base material in denture cleanser solution, regardless of the use of denture cleanser would decrease the flexural strength.

In this study, PMMA resin specimens were evaluated before and after immersion in two types of denture cleanser solutions to evaluate whether or not they will affect the flexural strength. Inter-group comparison of flexural strength between Corega tab, Fitty dent and Control group was done by using One-Way ANOVA test as is shown in Table 2 and Intergroup comparison for Control group and Corega tab, Control group and Fitty dent, Corega tab and Fitty dent was done by using student's T test as is shown in Table 3.

Significant differences were observed in the mean flexural strength values when comparing individual denture cleanser solution with control group.

Larger differences were observed in flexural strength of specimens immersed in Corega tab followed by Fitty dent denture cleanser solutions as compared to the control group.

Colour stability

Colour stability is one of the most important clinical properties for dental materials and colour change may be an indicator of aging or damaging of materials. Furthermore, the aesthetic appearance of prosthesis is certainly an important feature required by patients and must satisfy their expectations. The colour change of a polymeric material may be caused by intrinsic and extrinsic factors. Intrinsic factors involve resin discoloration itself and matrix changes, occurring during the aging process of the material due to many physical and chemical conditions. Furthermore, extrinsic factors such as thermal changes stain accumulation, artificial dyes used in food, cleaning procedures and handling by the patient can also cause discoloration. The colour and the colour differences of each specimen were measured with a spectrophotometer (Minolta, CM-3301d). The testing apparatus had a measuring head aperture of 10 mm diameter. Measuring characteristics of the spectrophotometer were set to standard illuminate D6, which is intended to represent average daylight. The spectrophotometer was connected to a computer system. Before each measurement session, the spectrophotometer was calibrated according to the manufacturer's recommendations by using the supplied white calibration standard. The specimens were centred on the measuring head of the spectrophotometer. The colour characteristics, tristimulus values X, Y, Z, and CIE (Lab) of specimens, were evaluated.

The CIE Lab system is an approximately uniformed colour space with coordinates for lightness, namely, white-black (L*), redness-greenness (a*), and yellowness-blueness (b*). This system makes it possible to evaluate the amount of perceptible colour change in each sample. L, a, and b values of each specimen before immersion and after immersion.The mean values of ΔL*, Δa*, and Δb* after measurements were automatically calculated by the spectrophotometer and recorded. Colour difference (ΔE*) was calculated from the mean ΔL*, Δa*, and Δb* values for each specimen with the formula:

$$\Delta E=\sqrt{(\Delta L)^2+(\Delta a)^2}+(\Delta b)^2$$

All the readings were recorded and used for the statistical analysis.

Table 4, 5 and graph 2 shows, the control group (n=10) consisting of denture base acrylic specimens immersed in distilled water (15mm x 4mm), has mean ΔE value of 1.46 which of specimens immersed in denture cleansing solutions has ΔE value of 2.81 & 2.06 respectively. This indicates that immersion of acrylic denture base material in denture cleanser solution, regardless of the use of denture cleanser shows significant colour changes.

In this study, PMMA resin specimens were evaluated before and after immersion in two types of denture cleanser solutions to evaluate whether or not they will affect the colour stability. Inter-group comparison of colour change between Corega tab, Fitty dent and Control group was done by using One-Way ANOVA test as is shown in Table 4 and Intergroup comparison for Control group and Corega tab, Control group and Fitty dent , Corega tab and Fitty dent was done by using student's T test as is shown in Table 5.

Significant differences were observed in the mean ΔE values when comparing individual denture cleanser solution with control group. Larger differences were observed in ΔE of specimens immersed in Corega tab followed by Fitty dent denture cleanser solutions as compared to the control group.

The results are in correlation with an in-vitro study by Peracini A *et al*., He evaluated the effects of denture cleansers (Corega tabs, Bony Plus) on colour change, surface roughness and flexural strength of heat polymerized acrylic resin.

He concluded that the colour changes were significantly higher for Corega tabs as compared to the control group. Bony Plus had a significantly higher surface roughness than the other groups. Corega tabs and bony plus groups presented significantly lower flexural strength than the control group [1].

Similar results were found by Robinson J G *et al*., who conducted a series of tests which were devised to assess the effect of subjecting acrylic resin denture materials, to denture cleanser at recommended and elevated temperatures. The results concluded that heat cured specimens which became whitened also suffered a reduction in flexural strength and microscopy indicated changes in the interstitial matrix of the two phase structure of the resins [11]. Subsequent studies done by Crawford C A *et al*., also concluded that

elevated temperature beyond manufactures recommendation caused a decline in flexural strength of denture base resin over repeated exposures. The studies emphasized that, the use of denture cleansers was a safe method for disinfection of dentures, the guidelines followed by the manufacturer should be followed [6].

The results are in correlation with another in vitro study by Neppelenbroek *et al*., demonstrated a significant reduction of mean hardness value for the denture base resin tested with sodium perborate solution. However, the flexural strength results comply with the minimum value (65 Mpa) set forth by ADA specification no 12, and it may have no clinical relevance [7].

A similar study conducted by Garcia R *et al*., to evaluated the effects of denture cleansers on the surface hardness and surface roughness of the denture base resin, Co-Cr and Ti-6Al-4V alloys. He found that cleanser manipulated using sodium perborate showed an increase in the surface roughness and hardness of Co-Cr alloys and Ti-6Al-4V alloys as well as denture base resins due to its inability to remove the pellicle formed on the acrylic resin and dental alloys [8].

On the contrary Sato S *et al*., assessed the flexural strength and colour alteration of acrylic resin, immersed in denture cleansers for various intervals. He found no significant differences in any of the denture cleansers (Bony Plus; Corega Tabs; Efferdent Plus and control) or between the soaking periods throughout the soaking cycles simulating 30 days of use. This is due to use of 30 days simulating effect when compared to the present study used 180 days of simulating effect [9].

Delvin and Kaushik showed that, water absorption on acrylic surfaces caused by peroxide solution, which showed irreversible damage to the mechanical properties of denture base resin [10].

Thewater sorption by acrylic resins causes dimensional instability and fatigue, which can cause crack formation and subsequently fracture of the denture [11]. Another factor involved with the mechanical properties is the residual methyl methacrylate monomer in the polymerized acrylic resin, which has a plasticizing effect [12].

The specimen of this study was immersed in distilled water for residual monomer elimination [13]. These results should be clinically interpreted with caution, because different results may be obtained when fatigue stress during function is combined with the chemical process of denture cleansers. If denture cleansers cause a decrease in strength, a higher incidence of denture fractures could occur.

Limitations of the study

In this study specimens were fabricated in accordance with ISO 1567 (1999) specification. Though the study was carried out with utmost accuracy, it has certain limitations which are enlisted below.

1. In spite of the following the standard protocol for preparing, curing and finishing of all specimens, the homogeneity of mix, presence of internal porosities and release of stress during acrylization, finishing and polishing procedures couldn't be controlled.
2. In the oral cavity, denture bases are exposed to varying forces acting in different directions. The same situation couldn't be simulated in this in vitro study.
3. In clinical situations, a uniform thickness of denture base resin may not be 3.3mm, as used in this study.

Scope for further study

1. To evaluate chemical interaction of denture cleansers on flexural strength and colour stability of poly methyl methacrylate.
2. Research with biofilm could influence the hygiene solutions.
3. Other conditions of oral environment should be simulated, such as continuous cyclic loading.
4. The testing period should be longer for the simulation of long term use and association with the mechanical cleaning methods could show potential interactions.

CONCLUSION

Within the limitations of the study, the subsequent conclusions were drawn:

- The flexural strength of heat polymerized denture base resin decreases after the immersion in denture cleanser solutions *viz*Corega tab and Fitty dent.
- The colour change of heat polymerized denture base resin shows significantly higher changes after immersion in denture cleanser solutions *viz*Corega tab and Fitty dent.
- Corega tabs show more reduction in flexural strength and higher colour change followed by Fitty dent denture cleansers.

REFERENCES

1. Shay, K. (2000). Denture hygiene: a review and update. *J Contemp Dent Pract*, *1*(2), 28-41.
2. Peracini, A., Davi, L. R., de Queiroz Ribeiro, N., de Souza, R. F., da Silva, C. H. L., & Paranhos, H. D. F. O. (2010). Effect of denture cleansers on physical properties of heat-polymerized acrylic resin. *Journal of prosthodontic research*, *54*(2), 78-83.
3. Paranhos, H. D. F. O., Peracini, A., Pisani, M. X., Oliveira, V. D. C., Souza, R. F. D., & Silva-Lovato, C. H. (2013). Color stability, surface roughness and flexural strength of an acrylic resin submitted to simulated overnight immersion in

denture cleansers. *Brazilian dental journal*, *24*, 152-156.
4. Neppelenbroek, K. H., Pavarina, A. C., Vergani, C. E., & Giampaolo, E. T. (2005). Hardness of heat-polymerized acrylic resins after disinfection and long-term water immersion. *The Journal of prosthetic dentistry*, *93*(2), 171-176.
5. Orsi, I. A., & Andrade, V. G. (2004). Effect of chemical disinfectants on the transverse strength of heat-polymerized acrylic resins submitted to mechanical and chemical polishing. *The Journal of prosthetic dentistry*, *92*(4), 382-388.
6. Crawford, C. A., Lloyd, C. H., Newton, J. P., & Yemm, R. (1986). Denture bleaching: a laboratory simulation of patients' cleaning procedures. *Journal of dentistry*, *14*(6), 258-261.
7. Neppelenbroek, K. H., Pavarina, A. C., Vergani, C. E., & Giampaolo, E. T. (2005). Hardness of heat-polymerized acrylic resins after disinfection and long-term water immersion. *The Journal of prosthetic dentistry*, *93*(2), 171-176.
8. Garcia, R. C. M. R., Júnior, J. A. D. S., Rached, R. N., & Del Bel Cury, A. A. (2004). Effect of denture cleansers on the surface roughness and hardness of a microwave- cured acrylic resin and dental alloys. *Journal of Prosthodontics: Implant, Esthetic and Reconstructive Dentistry*, *13*(3), 173-178.
9. Sato, S., Cavalcante, M. R. S., Orsi, I. A., Paranhos, H. D. F. O., & Zaniquelli, O. (2005). Assessment of flexural strength and color alteration of heat-polymerized acrylic resins after simulated use of denture cleansers. *Brazilian dental journal*, *16*, 124-128.
10. Devlin, H., & Kaushik, P. (2005). The effect of water absorption on acrylic surface properties. *Journal of Prosthodontics: Implant, Esthetic and Reconstructive Dentistry*, *14*(4), 233-238.
11. Beyli, M. S., & Von Fraunhofer, J. A. (1981). An analysis of causes of fracture of acrylic resin dentures. *The Journal of prosthetic dentistry*, *46*(3), 238-241.
12. Doğan, A., Bek, B., Cevik, N. N., & Usanmaz, A. (1995). The effect of preparation conditions of acrylic denture base materials on the level of residual monomer, mechanical properties and water absorption. *Journal of dentistry*, *23*(5), 313-318.
13. Council on Dental Materials and Devices. (1975). Revised American dental association specification no. 12 for denture base polymers. *The Journal of the American Dental Association*, *90*(2), 451-458.
14. Kuphasuk, W., Ponlasit, N., & Harnirattisai, C. (2018). Flexural strengths and color stability of bis-acryl resin materials for provisional restorations. *Mahidol Dental Journal*, *38*(2), 135-146.
15. Shah, V. R., Shah, D. N., Chauhan, C. J., Doshi, P. J., & Kumar, A. (2015). Evaluation of flexural strength and color stability of different denture base materials including flexible material after using different denture cleansers. *The Journal of the Indian Prosthodontic Society*, *15*(4), 367-373.
16. Kothari, P., & Hegde, V. (2019). Comparison and evaluation of color stability and flexural strength of various provisional restorative materials after bleaching: An in vitro study. *Journal of International Oral Health*, *11*(5), 293-298.
17. Kohli, S., Bhatia, S., Sexana, K., Kalsi, R., Rajeshwari, K., & Arora, M. (2017). Discolouration of polymethyl methacrylate versus Bisâ Acrylic based provisional crown and bridge dental resins: Effect of storage media and duration. *Annals of Medical and Health Sciences Research*, *7*(3), 195-199.
18. Llena, C., Forner, L., & Esteve, I. (2017). Effect of hydrogen and carbamide peroxide in bleaching, enamel morphology, and mineral composition: in vitro study. *The journal of contemporary dental practice*, *18*(7), 576-582.
19. Pereddy, M. R., Janani, S., Gupta, B., & Gajula, V. M. (2016). Comparative evaluation of hardness of four provisional restorative materials: An in vitro study. *European Journal of Prosthodontics*, *4*(3), 51-55.