e-ISSN: 0975-1556, p-ISSN:2820-2643
Available online on www.ijpcr.com
International Journal of Pharmaceutical and Clinical Research 2024; 16(3); 347-350

Original Research Article

Shrinkage Assessment of Different Denture Bases: A Comparative Study

Juhi Singh[1], Praveen Rai[2], Ashutosh Gupta[3], Arvind Tripathi[4], Ritika Sharma[5]

[1]Ex-SR, Department of Dentistry, SSMC, Rewa
[2]Reader, Department of Prosthodontics, Crown & Bridge, BBD College of Dental Sciences, Lucknow.
[3]Reader, Department of Prosthodontics, Crown & Bridge, Saraswati Dental College, Lucknow.
[4]Dean, P.G. Research & Studies, Head of Department of Prosthodontics, Crown & Bridge, Saraswati Dental College, Lucknow.
[5]Lecturer, Department of Prosthodontics, Crown & Bridge, Saraswati Dental College, Lucknow.

Received: 15-01-2024 / Revised: 20-02-2024 / Accepted: 05-03-2024
Corresponding Author: Dr. Juhi Singh
Conflict of interest: Nil

Abstract:

Introduction: Different polymers have been created and used therapeutically as denture foundation materials in dentistry. heat cure acrylic resin, was first released in 1937; this substance, when created via the compression molding method, continues to be the preferred denture foundation material. The volumetric shrinkage of resin is the main factor mentioned for the denture base's failure to adapt in the palatal and post-palatal seal region of maxillary dentures. Chemical activators, also known as cold-curing, self-curing, and autopolymerizing resins, were first employed in 1947 to induce polymerization at ambient temperature. photoinitiator systems with camphoroquinone as the initiator and visible light as the activator were used to create light-activated denture base resins.

Aims and Objective: The objectives of this study was to evaluate the dimensional and volumetric shrinkage in all the four (heat cure acrylic resin, cold cure acrylic resin, light cure acrylic resin and shellac base plate) denture base material.

Materials & Method: An in vitro experimental study was carried out, where 4 types of acrylic resin were compared; Group 1 heat cure acrylic resin (Denstply), group 2 Self cure acrylic resin (Dentsply), group 3 light cure acrylic resin (dentsply), group 4 Shellac base plate (Pyrex). A typical flexible rubber mold was used to create a total of 40 prostheses (n = 10 per group) from high strength dental stone (type III stone).

Conclusion : Dentures created using heat-cured acrylic resin displayed the maximum amount of polymerization shrinkage within the confines of the current investigation.

Introduction

Different polymers have been created and used therapeutically as denture foundation materials in dentistry. One such polymer, heat cure acrylic resin, was first released in 1937; this substance, when created via the compression molding method, continues to be the preferred denture foundation material. [1] The drawback of this material is processing-related curing shrinkage, which has an impact on the denture's stability and retention. The palatal and post-palatal seal regions of maxillary full dentures are particularly sensitive to its effects. The volumetric shrinkage of resin is the main factor mentioned for the denture base's failure to adapt in the palatal and post-palatal seal region of maxillary dentures. [2]

Shellac, which was used to make denture bases in the early to mid-20th century, was made from female lac found in forests in Thailand and India. It comes in the form of standard maxillary and mandibular arches. [3] If appropriately adapted, it is a great material for denture bases since it is quick, simple, and inexpensive to work with. However, because it is fragile and sensitive to shrinkage, shellac tends to warp when exposed to frequent temperature fluctuations. [4]

Chemical activators, also known as cold-curing, self-curing, and autopolymerizing resins, were first employed in 1947 to induce polymerization at ambient temperature. Incomplete polymerization results in decreased transverse strength and a potential tissue irritant, inferior color stability, and greater dimensional accuracy due to reduced polymerization shrinkage. Chemical activation is achieved by adding tertiary amine, such as Dimethyl-para-toluidene, to the monomer. [5,6]

In 1986, photoinitiator systems with camphoroquinone as the initiator and visible light as the activator were used to create light-activated denture base resins. These resins cannot be flasked in the traditional way because opaque media blocks the passage of light. These resins are non-toxic,

devoid of methyl methacrylate, less porous than chemically activated denture base resins, and show reduced polymerization shrinkage. [7-10]

Aims and Objective

The objectives of this study was to evaluate the dimensional and volumetric shrinkage in all the four (heat cure acrylic resin, cold cure acrylic resin, light cure acrylic resin and shellac base plate) denture base material.

Materials &Method

An in vitro experimental study was carried out, where 4 types of acrylic resin were compared; Group 1 heat cure acrylic resin (Denstply), group 2 Self cure acrylic resin (Dentsply), group 3 light cure acrylic resin (dentsply), group 4 Shellac base plate (Pyrex). The laboratory process for the manufacture of the prosthesis was made in the preclinical area of the Saraswati Dental College, Lucknow and the measurements were made in the engineering laboratory of the University of Babu Banarsi Das. A typical flexible rubber mold was used to create a total of 40 prostheses (n = 10 per group) from high strength dental stone (type III stone). On each cast, a record foundation made of several denture base materials (shellac base plates, heat cure, cold cure, and light cure) was created. Each occlusal rim made of cast wax had the following dimensions.

A typical flexible rubber mold was used to create a total of 40 prostheses (n = 10 per group) from high strength dental stone (type III stone). On each cast, a record foundation made of several denture base materials (shellac base plates, heat cure, cold cure, and light cure) was created. The following dimensions were prepared for the occlusal rim of each cast wax tooth.

Dimensions of Maxillary and Mandibular Occlusal RIMS

	Height	Width
Maxillary Anterior	22 mm from the deepest part of labial sulcus.	4-6mm.
Maxillary Posterior	20 mm from the deepest part of buccal sulcus.	8-10mm.
Mandibular Anterior	12-15 mm.	5mm.
Mandibular Posterior	20 mm from the deepest part of buccal sulcus or at the junction of anterior third and posterior one third of retromolar pad.	8-10mm.

Then, after being perfectly articulated on a mean value articulator and being sealed, the teeth arrangement was completed. Following the manufacturer's instructions, a conventional flasking process was employed with a Hanau curing unit (Hanau Engineering Company Inc., Buffalo, NY) and type II gypsum for the flask and type III gypsum (Whip Mix ®) for the countermuff Dewaxing then took place, and for the acrylization procedure, the manufacturer's precise instructions were followed by immersing a stove in water and regulating the temperature for each of the groups.

In order to measure the distance from the posterior edge of the prosthesis up to the corresponding limits in the stone model, measurements were taken in micrometers at three points located in the middle parts of the right and left alveolar ridges and the middle part of the palate using a digital microscope (Scientific AmScope). After the prosthesis was finished, the measurements were taken three times. The data were analyzed using unidirectional variance analysis (ANOVA) and the Tukey-Kramer HSD post hoc test with the statistical program SPSS statistics version 23 at a 95% confidence level to determine the mean differences for each study group. The mean values of polymerization shrinkage and standard deviation were calculated for each group.

Results

The average percentages of the contraction changes for the groups under study are shown in Table I. All groups showed a larger postpolymerization constriction towards the centre of the palate, with heat cure resin showing the most significant changes. ANOVA showed that the contraction is strongly related to the kind of acrylic resin processing cycle, which significantly affected the dimensions in all the samples (P 0.05). Although there is a difference in the measurements of the distance between the acrylic resin bases and the model, the difference between the groups under study is not statistically significant. The highest contraction was seen in the heat-cure polymerizing resin, followed by shellac.The order of polymerization shrinkage was Group 1>4>2>3.

Table 1: Post polymerization contraction (mm)

		Mean ± SD Contraction	95% Confidence interval for mean	
			Lower limit	Upper limit
Point 1	Group 1	350.06±169.62	250	450.12
	Group 2	200.22±57.07	85.38	315.06
	Group 3	130.13±66.32	80.12	180.14
	Group 4	300.76±86.03	189.48	412.04

Point 2	Group 1	930.22±93.70	760.1	1100.04
	Group 2	800.87±50.85	603.62	998.12
	Group 3	750.42±41.86	668.78	832.06
	Group 4	900.60±66.89	731.85	1069.35
Point 3	Group 1	553.65±62.29	474.76	632.54
	Group 2	340.83±18.04	237.44	444.22
	Group 3	300.05±29.47	167.98	432.12
	Group 4	500.33±21.95	329.45	671.21

Discussion

Complete acrylic resin prostheses exhibit some dimensional alterations that are unavoidable. Dimensional accuracy is significantly impacted by shrinkage during processing and expansion owing to water absorption, two significant factors. Due to modifications made to the resin during polymerization, the majority of complete maxillary dentures do not fit the cast exactly. This investigation confirmed that the base of the maxillary full prosthesis displays the highest disparity when the temperature and processing time changes in the posterior palatal seal region. [11,12]

The biggest dimensional changes, however, are found towards the back of the upper dentures (Abby et al., 2011). The range of discrepancy between the bases of the maxillary prosthesis and the moulds was only 0.129–0.286 mm, according to other authors, including Consani et al. [13] The posterior palatal region processed using the traditional packing technique showed the largest average dimensional change. [14] This conclusion contrasts with the findings of our investigation, where three measurements were taken and it was clear that the midway of the palate had the highest values of polymerization contraction. Additionally, Babu et al. [15] (2016) found that the posterior palatal sealing area of all created prosthetic bases was the least dimensionally stable region, and that denture bases made utilizing a long curing cycle would result in the most stable PMMA denture bases. In contrast, the heat resin with the longer curing period displayed more dimensional change in our investigation. [16]

When processing denture bases at a temperature higher than 72 °C, the temperature recommended by the producers of acrylic resins to accomplish complete polymerization, there have been reports of significant distortion of the denture bases (Passam et al., 2012). [17]

The heat cure resin displayed the highest values of linear dimensional changes when compared to the other materials examined in a study that tested the resins for PMMA prosthesis bases. Curing cycles could increase monomer conversion in the materials under investigation, which would result in dimensional alterations (El Bahra et al., 2013). [18,19] This circumstance is supported by the results of our study, which revealed that this material saw the greatest polymerization shrinkage inside acrylic resins that had undergone a heat cure. [20]

Acrylic resins continue to be the material of choice for prostheses despite the emergence of several base materials. Thermo-polymerized acrylic resins undergo dimensional changes as a result of thermal expansion during heating, shrinkage during cooling, polymerization, and expansion as a result of water absorption. [21,22]

These factors can be managed, but they cannot be totally taken out (Keenan et al., 2003). [23] After curing, the processed resins under investigation displayed dimensional changes that could have therapeutic implications and affect patient comfort, stability, and retention. These changes were measured linearly in the posterior and middle palatine area and in the area of the tuberosity. [24]

Conclusion

Dentures created using heat-cured acrylic resin displayed the maximum amount of polymerization shrinkage within the confines of the current investigation.

References

1. Abby, A.; Kumar, R.; Shibu, J. &Chakrav - arthy, R. Comparison ofthe linear dimensional accuracy of denture bases cured the by conventional method and by the new press technique. Indian J.Dent. Res., 2011; 22(2):200-4.
2. Akin, H.; Tugut, F. & Polat, Z. A. In vitro comparison of the cytotoxicityand water sorption of two different denture base systems. J. Prosthodont., 2015;24(2):152-5.
3. Artopoulos, A.; Juszczyk, A. S.; Rodriguez, J. M.; Clark, R. K. &Radford, D. R. Three-dimensional processing deformation of three denture base materials. J. Prosthet. Dent., 2013; 110(6):481-7.
4. Babu, S.; Manjunath, S. &Vajawat, M. Effect of palatal form on movement of teeth during processing of complete denture prosthesis: An in-vitro study. Contemp. Clin. Dent., 7(1):36-40,2016.
5. Braden, M. The absorption of water by acrylic resins and the rmaterials. J. Prosthet. Dent., 1964;14(2):307-16.
6. Consani, R. L.; Domitti, S. S. & Consani, S. Effect of a new tension system, used in acrylic resin flasking, on the dimensional stability of

denture bases. J. Prosthet. Dent., 2002; 88(3): 285-9.
7. Dixon, D. L.; Breeding, L. C. & Ekstrand, K. G. Linear dimensional variability of three denture base resins after processing and in water storage. J. Prosthet. Dent., 1992; 68(1):196-200.
8. El Bahra, S.; Ludwig, K.; Samran, A.; Freitag-Wolf, S. & Kern, M.Linear and volumetric dimensional changes of injection-molded PMMA denture base resins. Dent. Mater., 2013; 29(11): 1091-7.
9. Fenlon, M. R.; Juszczyk, A. S.; Rodriguez, J. M. & Curtis, R. V. Dimensional stability of complete denture permanent acrylic resin denture bases; A comparison of dimensions before and after a second curing cycle. Eur. J. Prosthodont. Restor. Dent., 2010; 18(1):33-8.
10. Firtell, D. N.; Green, A. J. & Elahi, J. M. Posterior peripheral sealdistortion related to processing temperature. J. Prosthet. Dent.,45(6):598-601, 1981.
11. Gharechahi, J.; Asadzadeh, N.; Shahabian, F. & Gharechahi, M. Dimensional changes of acrylic resin denture bases: conventional. Vallejo-Labrada, M. & Ocampo, B. L. C.
12. Comparison of the polymerization shrinkage of Eclipse resin for prostheses with conventional acrylic resins. Int. J. Odontostomat.,2019; 13(3):279-286.
13. Conventional versus injection-molding technique. J. Dent. (Tehran), 2014; 11(4):398-405.
14. Keenan, P. L.; Radford, D. R. & Clark, R. K. Dimensional change incomplete dentures fabricated by injection molding and microwave processing. J. Prosthet. Dent., 2003; 89(1):37-44.
15. Lamb, D. J.; Samara, R. & Johnson, A. Palatal discrepancies and postdams. J. Oral Rehabil., 2005; 32(3):188-92.
16. Lim, S. R. & Lee, J. S. Three-dimensional deformation of dry-stored complete denture base at room temperature. J. Adv. Prosthdont., 2016; 8(4):296-303.
17. Machado, C.; Sanchez, E.; Azer, S. S. & Uribe, J. M. Comparative study of the transverse strength of three denture base materials. J. Dent., 2007; 35(12):930-3.
18. McCabe, J. F. & Wilson, H. J. The use of differential scanning calorimetry for the evaluation of dental materials. Part II. Denturebase materials. J. Oral. Rehabil., 7(3*)*:235-43, 1980.
19. Mowery, W. E.; Burns, C. L.; Dickson, G. & Sweeney, W. T. Dimensionalstability of denture base resins. *J. Am. Dent. Assoc.,1958; 57(3)*:345-53.
20. Pasam, N.; Hallikerimath, R. B.; Arora, A. &Gilra, S. Effect of different curing temperatures on the distortion at the posterior peripheral seal: an in vitro study. Indian. J. Dent. Res., 2012; 23(3):301-4.
21. Skinner, E. W. & Cooper, E. N. Physical properties of denture resins: Part I. Curing shrinkage and water sorption. J. Am. Dent. Assoc., 1943; 30(23):1845-52.
22. Soto Pe., J. M. & L.pez Salgado, A. Comparaci. n de cambios dimensionalesen bases prot.sicas de acr. licoscuradospor calory microondas. Rev. Odontol. Mex., 2004; 8(1-2):10-6.
23. Wong, D. M.; Cheng, L. Y.; Chow, T. W. & Clark, R. K. Effect of processing method on the dimensional accuracy and waters orption of acrylic resin dentures. J. Prosthet. Dent., 1999; 81(3*)*:300-4.
24. Yeung, K. C.; Chow, T. W. & Clark, R. K. F. Temperature and dimensional changes in the two-stage processing technique for complete dentures. J. Dent., 1995;23(4):245-53.