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Comparative Evaluation of the Retention of Maxillary Complete Denture Bases Made by Heat Cure Acrylic Resin Processed on High Expansion Stone and Type III Dental Stone: An In-Vivo Study

Shruti Keerthi Thota[1], Mahalakshmi Gujjalapudi*[2], Chandrasekar Anam[3], Radha Chiluka[4], Praveen Mamidi[5], Swaroopkumar M Magar[6]

[1]MDS Prosthodontics, 12445 AlamedaTrace Cir, Apt 118, Austin, Texas, 78727; [2]Associate Professor, Department of Prosthodontics, Government Dental College, Kadapa, Andhra Pradesh, India; [3]Professor and Head, Department of Prosthodontics, SVS Institute of Dental Sciences, Mahboobnagar, Telangana, India; [4]Reader, Department of Prosthodontics, Panineeya Mahavidyalaya Institute of Dental Sciences, road no.5, Kamala Nagar, Chaithanyapuri, Hyderabad, Telangana-500060, India; [5]Professor and Head, Department of Prosthodontics, Panineeya Mahavidyalaya Institute of Dental Sciences, Raod no 5, Kamala nagar, Chaithanyapuri, Hyderabad,Telangana-500060, India; [6]Reader, Department of Prosthodontics, Saraswati Dhanwantari Dental College and Research Institute, Perbhani, Maharashtra, India.

ABSTRACT

Introduction: Accurate fit of the complete denture is the most important factor in prosthodontic practice. The primary contributors for the retention are the good base adaptation of a denture to underlying mucosa and the border seal. Despite the success of acrylic resins as denture base materials, the dimensional changes caused by them must be accepted as one of the disadvantages of acrylic resin dentures.

Objectives: The present study aimed to investigate the retention of maxillary complete denture bases made on type III and type V dental stones.

Methodology: 15 completely edentulous patients who needed prostheses were included in this study. After primary and secondary impressions, two casts were prepared from the mould, one using the type-III dental stone and another with type-V stone. Thermoplastic resin gaskets of 2 mm in thickness were used to prepare denture bases models on both casts. Heat cure denture bases were fabricated on the prepared casts and retention was measured using an electronic scale.

Results: It was observed that the mean retentive force increased up to 30% with denture base made on type V dental stone (mean retentive force 4.46N) than denture base made on type III dental stone (mean retentive force 3.12N).

Conclusion: Based on the study findings, it was concluded that denture bases made on type V stone compensated to a substantial degree for the shrinkage of acrylic resin and plays an important role in obtaining the optimum retention of the maxillary complete denture.

Key Words: Maxillary complete denture, Retention, Type III dental stone, Type V dental stone

INTRODUCTION

Denture retention is defined as "resistance of a denture to vertical movement away from the tissues".[1] In simple words, it refers to the force which resists the displacement of a denture in occlusal direction. It is a well- known fact that the accurate fit of the denture base to the mucosal tissue and border seal plays an important role in enhancing the retention and stability of the complete denture. [2] Various factors such as adhesion, cohesion, interfacial surface tension, atmospheric pressure, viscosity, base adaption, border seal, muscular control etc. have all been cited as major or contributory factors in affecting retention. However, it was observed that not all the factors as they claimed are responsible for affecting complete denture retention and failed to survive scientific scrutiny. [3]

Acrylic polymer resins i.e. polymethyl methacrylate (PMMA) are the commonly used denture base materials for the past 60 years. Despite its drawbacks such as shrink-

Corresponding Author:
Dr. Mahalakshmi Gujjalapudi, Associate Professor, Department of Prosthodontics, Government Dental College, Kadapa, Andhra Pradesh, India; Email: gmahalakshmi@gmail.com

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age and dimensional changes during polymerization, it remained as the material of choice for denture base fabrication [4,5,6] reported that the dimensional changes in the denture occur irrespective of the processing techniques or the acrylic resin is chosen. The first unavoidable dimensional change is shrinkage, which occurs during processing and finishing (0.3- 0.5%). The second change is the linear expansion of 0.1- 0.2%, which occurs due to the storage of the dentures in a water bath or due to the absorption of oral fluids while in the oral cavity.[7,8,9]

Various studies have been conducted in the past analysing the retention of maxillary denture base with and without border molding, different border molding materials, different border molding techniques, different posterior palatal seals etc. [10-13] However, little research has been done, to study the influence of the type of dental stone used to fabricate the cast. It is found that the coefficient of linear expansion in type III dental stone and increased expansion of type V stone compensates for the dimensional changes resulting from shrinkage in denture bases. [14] The present study was conducted to evaluate and compare the retention of maxillary complete denture bases made on type III and type V dental stones. The null hypothesis was that there would be no significant difference in the retentive forces applied on the denture base fabricated on type III and type V dental stone.

MATERIALS AND METHODS

Sample selection

Fifteen completely edentulous patients who required prostheses were included in this study. The study was carried out in the Prosthodontics Department of Panineeya Institute of Dental sciences. Prior approval was obtained from the ethics committee of the institution to conduct the study. Patients with maxillary edentulous arch, with a minimum of 6 months of healing period following extraction, with no signs of infection, well-healed, round, smooth, resilient and thick oral mucosa covering the ridge were included. Ridges without any unilateral or bilateral undercuts were selected. Patients who had limited mouth opening and with abnormal Salivary slow were excluded from the study.

Methodology

The primary impression of the denture bearing area was obtained with impression compound (DPI, Pinnacle), special trays were fabricated using self-cure acrylic resin and were border molded to get an acceptable extension and border thickness. The master cast was then obtained from the final impression, which is then positioned and sealed using modelling wax in the duplicating flask and duplicated using duplicating silicone (Unisil Flow, Chennai). Two casts were prepared from the mould, one using the type-III dental stone(Kalabhai enterprises, India) and another with type-V stone (Hardrock, whip mix, USA). Thermoplastic resin gaskets of 2 mm in thickness were used to prepare denture base models on both casts (**Figure 1**). The clear resin bases were invested and the molds thus obtained were packed with heat cure acrylic resin(Dentsply, UK) to prepare permanent denture bases. Flasks containing the bases were kept in room temperature water, the temperature was gradually raised to 74^0C and maintained for 9 hours in a thermostatically controlled acrylization unit.

After polymerization, the flasks were allowed to bench cool for one hour, and the denture bases were removed carefully. Any remnants of stone or blebs of acrylic resin were removed carefully with the help of acrylic resin bur under magnification. The denture bases were polished; handles were fabricated on the trays using self- cure acrylic resin (DPI) (**Figure 2**). The denture bases were then subjected to evaluation of retention.

For measuring retention, an electronic scale was used (**Figure 3**). The maximum amount of force required to dislodge the maxillary denture bases was measured using this scale. The retention of the maxillary denture bases was tested after they remained in the patient's mouth for a minimum of 15 to 20 minutes. The patient was then made to seat in a comfortable position and was instructed not to exert any pressure on the denture base with the tongue. The electronic scale was then attached to the specially made handle to the denture base (**Figure 4**). The amount of load was gradually in the electronic scale till the maxillary denture base dislodge and the readings were noted down.

Statistical analysis: Collected data were analysed with *t*-test statistics for statistically significant differences at the 95% confidence level. Statistical analysis was performed using software IBM SPSS version 20.0. A value of $P<0.05$ was considered statistically significant.

RESULTS

The amount of forces applied to dislodge the denture bases were considered as the retentive values. For each patient, five readings were taken for the type III and type V denture bases of each patient and the mean of these values was obtained.

Group 1 i.e. type III dental stone showed the minimum value, in the range of measurement of dislodging force, to be 1.56N and the maximum value to be 5.09N, with an averaging group mean of 3.12N respectively. Group 2 i.e. type V dental stone showed the minimum value, in the range of measurement of dislodging force, to be 3.02N and the maximum value to be 6.32N, with an averaging group mean of 4.46N respectively (**Table 1**).

The computed value of the "independent t-test" was highly

significant (p= 0.002) implying that the means of the two groups i.e. type III and type V dental stone were highly different from each other. In simple words, the mean force required to dislodge denture bases made on type V stone (4.46N) was larger than the mean force to dislodge denture bases made on type III stone (3.12N) at p<0.05 level.

The variations among the observations on the force of dislodgement concerning type III and type V dental stones have been depicted diagrammatically (**Figure 5**).

DISCUSSION

Following the results of the present study, the stated null hypothesis was rejected, meaning the use of maxillary denture bases made on high expansion type V dental stone exhibited higher retention than type III dental stone.

Despite many factors cited for the retention of the complete dentures, only a few have survived the scientific scrutiny. They include surface tension, base adaptation, viscosity, seating force, soft tissue and time. Many believed that good base adaptation and border seal as primary contributors for the retention of the denture base and must be achieved. [15, 16] even though the denture bases fabricated using acrylic resins have desirable characteristics, both shrinkage and expansion are inevitable. Even though the properties of acrylic resins in complete dentures were improved, the problem persists. [17] In 1996, Sykora and Sutow, investigated the ability of high expansion stone in reducing the processing distortions of acrylic resin denture bases. They found that the denture bases processed on high expansion stone had better posterior palatal seal adaptation (Sykora and Sutow,1996). Again in 1997, the same authors tested the ability of high expansion stone in compensating for some of the dimensional changes occurring in acrylic denture bases. Their results demonstrated that expansion of the stone can help compensate for shrinkage that occurs in acrylic resin material.

The findings of the present study showed that the use of type V dental stone improved the fit of the maxillary complete dentures compared with type III dental stone. Type V dental stones have exhibited a mean dislodging force of 4.46N (ranging from 3.02N to 6.32 N)which is significantly higher than type III stone, which has a mean dislodging force of 3.12N (1.56N to 5.09N). It shows that approximately 30% increase in the retentive force of maxillary denture bases made on type V dental stone compared to those made on type III stone. The results of the present study suggest that the maxillary denture bases processed on type V dental stone had provided better retentive force, which in turn indicates better denture adaptation.

The present in vivo study has some limitations. Few subjects who were involved in this study were previous denture wearers. Denture wearers, usually learn to effectively control the dentures and master patterns of orofacial muscular activity, serve to retain, rather than displace, their prosthesis. [18] We believe that these retention values are not a true reflection of retentive force offered by the denture base fabricated on dental stone, but is a combination of effective muscular control of denture wearers and dental stone. To avoid the bias from muscular retention, we constantly reminded the patients to relax their cheeks and other muscles, and the average of repetitive measurements was considered for statistical analysis. The authors only have measured the dislodging forces on single occasion. They have not studied the effect on the retention of denture bases due to immersion in water for up to one week, as evidence suggested that water sorption can help compensate for processing shrinkage by expanding the denture.[19,20,21] The retentive forces of the denture bases made on type III and type V dental stones must be verified at different time intervals. Lastly, the authors did not analyse the setting expansion of type III and type V dental stones. Further research is needed to understand how much compensation is acquired using type III and type V dental concerning the polymerisation shrinkage of the acrylic denture bases.

CONCLUSION

Within the limitations of the present in vivo study, it can be concluded that the maxillary denture bases fabricated on type V dental stone had offered better retention than the denture bases fabricated on type III dental stone. This recommends the use of type V dental stone, which is especially beneficial in situations where retention is compromised due to anatomic factors.

Conflict of Interest: None

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Authors contribution

1. Keerthi Thota S – Data collection
2. Gujjalapudi M – Study design
3. Anam C - Investigation
4. Chiluka R – Manuscript writing
5. Mamidi P- Editing
6. Magar SM- Review

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Table 1: Independent t-test comparing the values of mean dislodging force and range among type III and type V dental stone

Group Statistics						
	Group	N	Mean	Std. Deviation	Minimum	Maximum
Force	Type- III	15	3.1233	1.04570	1.56	5.09
	Type V	15	4.4647	1.11169	3.02	6.32

t-test for Equality of Means							
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Force	-3.41	28	0.002*	-1.34133	0.39407	-2.14855	-0.53412

*Statistically significant

Figure 1: Denture Base models prepared with thermoplastic resin sheet of 2mm thickness using a vacuum forming machine.

Figure 2: Finished and polished heat cure acrylic bases with handles processed with self-cure acrylic for checking the retention in the patient.

Figure 3: Electronic scale used to measure the load required to dislodge the denture bases.

Figure 4: Retention of maxillary bases fabricated on type-III & Type-V stone casts evaluated in the patient using an electronic scale.

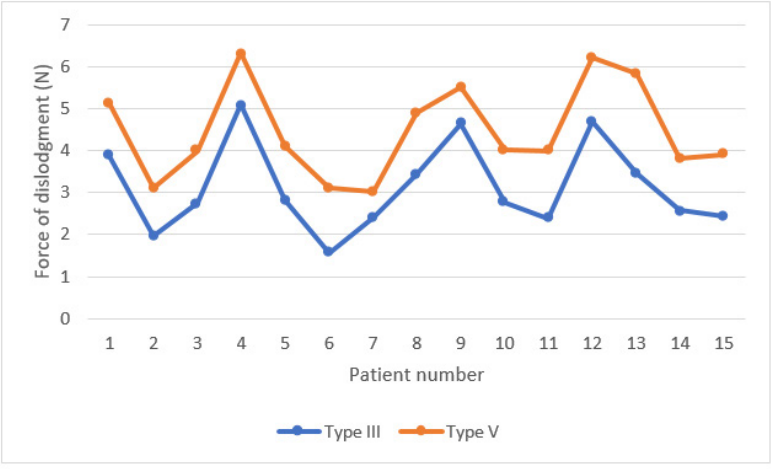

Figure 5: Pattern of the force of dislodgement in two study groups.