Original Article

Retention of denture bases fabricated by three different processing techniques — An *in vivo* study

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Abstract

Aim: Distortion due to Polymerization shrinkage compromises the retention. To evaluate the amount of retention of denture bases fabricated by conventional, anchorized, and injection molding polymerization techniques. **Materials and Methods:** Ten completely edentulous patients were selected, impressions were made, and master cast obtained was duplicated to fabricate denture bases by three polymerization techniques. Loop was attached to the finished denture bases to estimate the force required to dislodge them by retention apparatus. Readings were subjected to nonparametric Friedman two-way analysis of variance followed by Bonferroni correction methods and Wilcoxon matched-pairs signed-ranks test. **Results:** Denture bases fabricated by injection molding (3740 g), anchorized techniques (2913 g) recorded greater retention values than conventional technique (2468 g). Significant difference was seen between these techniques. **Conclusions:** Denture bases obtained by injection molding polymerization technique exhibited maximum retention, followed by anchorized technique, and least retention was seen in conventional molding technique.

Key words: *Acrylic resins, anchorized technique, injection molding technique, retention apparatus*

INTRODUCTION

Among various treatment modalities available for edentulous patients, conventional complete denture treatment still continues. Dentists should aim at fabricating good quality dentures to improve comfort and function of the patient. Retention plays a vital role in the success of the complete denture, and therefore every stage of denture construction should be given due importance. Effective retention is attained by the close mucosal contact of the denture base.[1] The physical factors that arbitrate the retention of a complete denture are adhesion, cohesion, salivary film thickness, surface tension, and atmospheric pressure. The greater the surface tension and thinner the fluid film, the greater will be the retention. Dimensional stability and accuracy of the denture base will lead to intimate adaptation to the oral tissues. Denture base resin polymers were introduced in 1937, and even today, polymethyl methacrylate (PMMA) is the material of choice for the fabrication of the majority of dentures. During the polymerization process, dimensional shrinkage

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of the resin occurs. Shrinkage, which is caused by the differences in the densities of the monomer and the polymer, results in a lifting of the denture base away from the posterior palate as a result of polymerization.[2] Dissimilitude is also introduced during the cooling of heat-cured denture bases because of a relatively high coefficient of thermal expansion of acrylic resin compared with the gypsum investing medium. Attempts to overcome the polymerization shrinkage with conventional polymerization technique have resulted in the development of various methods such as the injection molding technique and mechanically anchoring the denture base resin to the master cast during processing. Some authors reported that dentures made of injection molding heat cured PMMA acrylic resin were more retentive than other denture base materials.[3,4] Laughlin *et al.*[5] reported that mechanical anchorage holes improve adaptation of denture bases to palatal tissues and enhance retention. On the other hand, denture adhesives improve retention and stability for ideal as well as for compromised ridges.[6,7] However, these adhesives showed carcinogenic changes in the underlying tissues.[8] This *in vivo* study was performed to determine the effect of conventional, anchorized, and injection molding processing techniques on the retention of maxillary denture base.

MATERIALS AND METHODS

Thirty edentulous patients who reported to the Department of Prosthodontics were screened. Based on the clinical examination, evaluation of the diagnostic cast and patients who had been edentulous for varying periods of 6 months to 1 year, 10 patients with an average age of 50–60 years were selected following inclusion criteria. Simple random sampling technique was used for the data collection in this study.

- Patients with good neuromuscular control and free of systemic diseases;
- Well-formed ridges with healthy, firm mucosa; and
- Without any bilateral and anterior maxillary undercuts.

This study was carried out from January to June 2015 for a period of approximately 6 months. The patients were informed about the procedure, after taking ethical committee approval, and informed consent was obtained. All the 10 subjects were instructed not to wear their dentures a week before their appointment for impressions. Preliminary impression was made with modeling plastic impression compound (Y-Dents, MDM Corp., India), and custom tray was fabricated on diagnostic cast with auto polymerizing acrylic resin (DPI-RR Cold cure, India). Final impression was made using monophase impression material (Provil, Kulzer, Germany), master cast poured in type III gypsum (Kalabhai, India). Arbitrary scrapping of posterior palatal seal was done on the master cast [Figure 1]. Master cast of each subject was duplicated with reversible hydrocolloid duplicating material (Wirogel M, BEGO, Bremen), and two duplicate casts were obtained.

Denture base fabrication by conventional technique (Technique A)

On the master cast, 2 mm thick baseplate wax (Indu; India) was adapted and processed with conventional heat cure technique for approximately 9 h at 74°C in water bath for polymerization. Bench cooling of the flasks were done and the denture base was retrieved from the cast, finished, and polished.

Denture base fabrication by Anchorized technique (Technique B)

Mechanical anchorage was attained by placing holes in the casts along 1 mm distal to the posterior border of the denture base in the midline region with 5 mm intervals laterally. The holes were placed with a Standard number 8 round burr to a depth of 5 mm using self-cure acrylic resin template [Figure 2]. The burr was placed at right angles to the cast surface, which was held by hand.[5] 2 mm thick baseplate wax was adapted on the cast and extended to cover the anchoring holes. Denture base processing was carried out similar to the conventional method. The resulting resin tags were trimmed and the denture base was finished and polished.

Denture base fabrication by injection molding technique (Technique C)

2 mm thick baseplate wax was adapted on the cast, and using the Ivocap flask the denture base

Figure 1: Arbitrary scrapping of the master cast

was fabricated according to the manufacturer's instructions. Premeasured capsules of the resin and monomer (20 g polymer, 30 ml monomer) were mixed for 5 min in cap vibrator (Ivoclar AG) before injecting into the flask. Hydraulic pressure of 6 atm Figure 3 was maintained for 5 min before placing the assembly into boiling water (100°C) for 35 min. The assembly was taken out and immersed in cold water for 20 min before removing the denture base from the flask.

Testing procedure

At the mid palatal portion of each denture base, a loop made of 19 gauge stainless steel wire was affixed with autopolymerized acrylic resin (DPI-RR Cold cure) [Figure 4]. Denture bases were checked for stability, and evaluation of tissue surface was performed with pressure indicating paste. All the tests were performed by the same operator. To test for retention, vertical dislodging forces were applied to the bases at preselected locations using pulley suspended retention apparatus [Figure 5]. This device consists of two pulleys units (first pulley was nonadjustable and the second pulley was adjustable), weighing pan, and a tension-free nylon thread. One end of the nylon thread was hooked to a stainless steel loop attached to the denture base. The other end of the thread was attached to a weighing pan through a pulley. The second pulley unit was adjusted to the level of subject's occlusal plane. Both these pulleys were clamped to the table.

The subjects were seated in an upright position, and head was stabilized with cephalostat [Figure 6], such that the Frankfurt horizontal plane and floor were parallel to each other. The subjects were instructed to partially open the mouth so that the nylon thread would not come into contact with the tongue and lip. The maxillary denture base was inserted in the patient's mouth and allowed to remain for a "settling" time of 3 min before denture base loop was engaged. Weights were loaded gradually in an increasing manner into the weighing pan for every 10 s. Test carried till the

Figure 2: Mechanical anchoring holes placed in cast

Figure 3: Injection of resin into flask under hydraulic pressure

Figure 4: Stainless steel loop placed at mid palatal portion of denture base

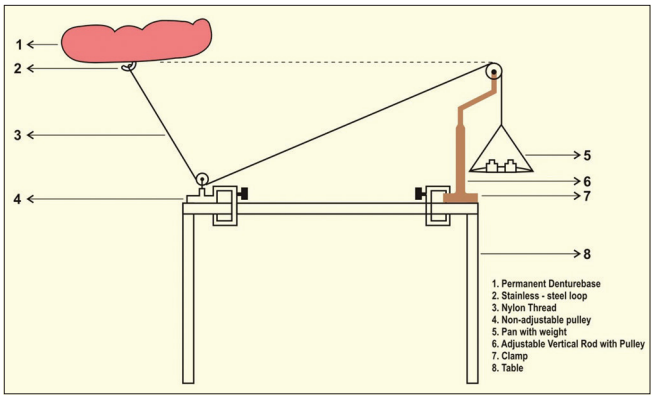

Figure 5: Line diagram showing testing apparatus

Figure 6: Test with Pulley suspended retention apparatus

patient reported the dislodgement of denture base from the palate. Number of grams (g) in the pan was recorded to be the force required to dislodge the denture base in the mouth. Each subject were tested for three different denture bases, and three readings were recorded for each of the denture base. A total of 90 readings were obtained from these 10 patients. Averages of these weights were considered to be the magnitude of the force required to dislodge the denture base. Before and after each test, the patients were asked to rinse their mouth with water, so that a constant quality and quantity of saliva was maintained. Results were subjected to the statistical analysis of non-parametric Friedman two-way analysis of variance followed by Bonferroni correction methods and Wilcoxon matched-pairs signed-ranks test. This analysis is used to detect differences in retention for repeated measurements of each technique on a single subject to assess their mean and is used as an alternative to the paired students *t*-test and to counteract the problems encountered by multiple comparisons.

RESULTS

The mean and standard deviation for the retention of denture bases processed by the 3 techniques are presented in Table 1. Mean retentive value for technique C was 3740 g; mean retentive value for technique B was 2913 g; and the lowest mean retentive value was for technique A 2468 g. There was a mean difference of 445 g between technique A and technique B, 1272 g between technique A and technique C and 827 g between technique B and technique C. The mean values obtained by all 3 techniques have significant difference with each other ($P < 0.05$) [Table 2].

Table 1: Values for conventional, anchorized and injection molding processing techniques of the 10 subjects

S. No	Conventional processing technique (Technique A) grams	Anchorized processing technique (Technique B) grams	Injection molding technique (Technique C) grams
1	1430	1480	1590
2	3400	3700	4280
3	4500	5150	5950
4	410	590	720
5	730	830	1130
6	1150	1820	2750
7	1500	2250	2900
8	4740	5400	8200
9	4170	4560	5300
10	2650	3350	4580
Mean	2468	2913	3740
±SD	±1636	±1768	±2368

SD=Standard deviation

Table 2: Comparison between techniques

Comparisons between techniques	*P*	Significance
A vs. B	<0.05	Sig
A vs. C	<0.05	Sig
B vs. C	<0.05	Sig

A=Conventional processing technique, B=Anchorized processing technique, C=Injection molding technique. Friedman two-way ANOVA, Wilcoxon matched-pairs signed-ranks test and Bonferroni's correction test. P<.05

DISCUSSION

The most popular denture base material for practitioners use is heat cured acrylic resin.[4] Shrinkage of acrylic resin because of the curing process has always been a challenge. Several processing methods and denture base materials have come into the market which have overcome this shrinkage. Many investigators have examined the long-term usage of various resins and processing techniques for clinical evaluation. Their processing variables and effects have also been researched.[9,10] Definite techniques are advocated to maximize the quality and accuracy and minimize the shrinkage of the processed complete denture, tooth movement, and pin opening on the articulator. Vig[11] developed a postpalatal extension to decrease the anterior migration of denture teeth in processing. Ristau[12] advocated the Ristau post dam to decrease the postpalatal separation. Pryor[13] introduced injection processing of PMMA in an attempt to reduce processing shrinkage. Denture bases were used in the study to eliminate the problems with tooth movement

during investment and processing. The loop placed in the midpalatal region was used to load the denture bases because it is the most reliable region for testing the retention of complete dentures, as concluded by Colon *et al.*[14]

Objective methods using measurement equipment are proven to be more reliable clinically to check the degree of complete denture retention.[15,16] Hence, in this study, an retention apparatus was used to evaluate the effect of processing techniques on the retention of the denture bases.

For 10 completely edentulous patients, impressions were made. On the duplicated casts, 3 maxillary denture bases were fabricated for each patient with different polymerization techniques. Retention was evaluated 3 times with each denture base and the mean value was calculated. Maxillary denture bases processed with injection molding technique (3740 g) had maximum retention compared to other 2 techniques. The anchorized technique (2913 g) had better adaptation than that of the conventional polymerized method (2468 g).

Anchoring the denture base during processing might have reduced the shrinkage in accordance with study done by Laughlin *et al.*[5] and improved the intimacy of the denture base to the underlying mucosa thereby improving the retention when compared to the conventional processing technique. The maximum retention values by injection molding technique are probably due to an application of continuous hydraulic pressure to a reservoir of unpolymerized resin compensates polymerization shrinkage.[4]

Limitations

In the present study, retention of only denture bases under static load on small sample size was checked.

- The rate of edentuluism has been declined worldwide from past to present decade.[17,18] Lack of retention was one of the major complaints of complete denture patients.[19-22] Even though implant supported dentures improve retention, because of its cost factor and compromised medical condition most of the patients prefer conventional treatment procedures.[23] Therefore, in this study, effect of processing technique on retention was evaluated; close adaptation to underlying tissues also improves patients' denture hygiene
- Only denture bases were used; problems regarding vertical dimension changes and occlusal errors were not considered
- Future studies should be carried out to investigate the retention of complete dentures instead of denture bases in various time intervals after patients usage and various processing errors have to be minimized.

CONCLUSIONS

Within the limitations of this study following conclusions were drawn:

The retention of denture bases cured by the three polymerization techniques was tested. The denture bases cured by injection molding technique exhibited maximum retention other than those cured by either conventional and anchorized processing methods. Clinical efficacy of injection molding technique was significantly higher when compared to conventional and anchorized polymerization techniques in providing retention to denture base.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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