ORIGINAL ARTICLE

A COMPARATIVE ANALYSIS OF RETENTION OF DENTURE BASES WITHOUT AND AFTER SURFACE TREATMENT OF BASAL SURFACE WITH DIFFERENT SIZES OF ALUMINA PARTICLES – AN IN VIVO STUDY

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ABSTRACT:
Objective: The objective of the present study was to evaluate effect of roughness of the basal surface and increase in its surface area on retention of maxillary denture bases, and compare the retention of the denture bases after surface treatment with different sizes of alumina particles. **Materials and Methods:** Twenty healthy subjects with edentulous maxillary ridge and good oral hygiene were selected as a part of this study. After duplication of master cast three acrylic resin denture bases were fabricated for each subject. A specially designed retention apparatus consisting compact force gauge was used to measure retention values of these denture bases. Retention values for the first denture base were measured without air abrasion (sandblasting), whereas retention values for second and third denture bases were measured after air abrasion of the basal surface with 50µ and 100µ alumina grit sand. **Results:** There was a significant increase in retention values ($p<0.05$) of the denture bases after air abrasion of basal surface with 50µ and 100µ alumina grit sand in comparison to the retention of the denture bases without air abrasion. Although the denture bases air abraded with 100µ alumina showed improvement in retention when compared to the denture bases air abraded with 50µ alumina, this improvement was statistically non significant ($p>0.05$). Conclusion: Air abrading the basal surface significantly improved retention of the denture bases. Further studies are required to evaluate retention of denture bases following air abrasion with different particle sizes.
Key words: Air abrasion, Denture base, Basal surface, Retention

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INTRODUCTION

The success of a complete denture relies on three basic factors i.e. retention, stability and support; and these three factors play an important role in the satisfaction of the complete denture patient. Retention relates to the forces that are necessary to completely remove the denture from its basal seat and it is one of the main prerequisites for the success of a prosthesis.[1,2]
The Glossary of Prosthodontic Terms (GPT-8) has defined denture retention as the resistance in the movement of a denture away from its tissue foundation especially in a vertical direction and it is a quality of a denture that holds it to the tissue foundation and/or abutment teeth.[3]

The retention of complete dentures may be influenced by physical, physiological, psychological, mechanical and surgical factors.[4] The physical factors affecting retention include adhesion, cohesion, interfacial surface tension, atmospheric pressure, viscosity and capillary attraction.[5-10] A sufficient layer of saliva is essential for retention as a result of physical effects.[5,8,9-11] Thus, denture retention is understood to be a function of salivary surface tension, its viscosity, the thickness of the salivary film, the contact surface and the saliva - denture contact angle.[9] The adhesive action of salivary film between the oral mucosa and the intaglio surface of a complete denture is recognized as one of the principal source

of physical retention in a well adapted denture.[12,13] This study aimed to examine the effect of roughness of the basal surface and increase in its surface area on retention of maxillary denture bases, and compare the retention of the denture bases after surface treatment with different sizes of alumina particles.

MATERIAL AND METHODS

The present study was conducted on tw 102 edentulous subjects, who reported in the Department of Prosthodontics, H.P Government Dental College, Shimla, Himachal Pradesh.

The study was carried out in the following manner:

1. Evaluation of the patient
2. Making edentulous impression
3. Duplication of master cast
4. Fabrication of acrylic resin test bases
5. Measurement of retention of denture bases
   - Testing apparatus
   - Sandblasting the denture bases
   - Testing procedure
6. Analysis of data

Evaluation of the patient

The subjects were evaluated for the following selection criteria:

1. Healthy subjects with completely edentulous maxillary ridge.
2. Patients without any systemic diseases or controlled systemic diseases.
3. Maxillary ridge with minimal or no undercuts.

Making edentulous impressions

Primary impressions were made using impression compound (Pyrex Polykem) and the casts were poured in dental stone (Type III, Gypstone – Prevest Dentpro). Custom trays were fabricated on primary cast in auto-polymerizing acrylic resin (DPI Bombay Burmah Trading Corporation Ltd.), tried in patient's mouth and checked for comfort and extension. Thereafter, border molding was done by manual and functional movements using low fusing compound (green stick) and secondary impression was made with Zinc oxide Eugenol impression paste (DPI). After verification, the impression was poured in Dental Stone (Type III) and master cast was fabricated following powder and water ratio as per the directions of the manufacturer.

Duplication of the master cast

The maxillary cast was indexed with four triangular notches in the land area on the lines joining canine eminences and hamular notches for identical reference positions. The indices on canine eminences were marked as A and B, and those on hamular notches as C and D. The indexed cast (Fig. 1a and 1b) was duplicated using reversible hydrocolloid impression material (agar-agar, Bego-USA). Total three casts were fabricated in Dental Stone (Type III) and were designated as A_W, A_{50} and A_{100}.

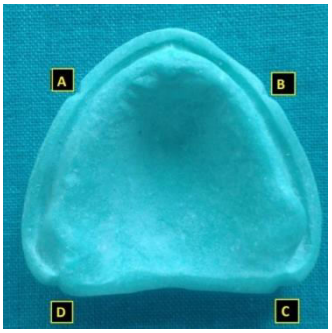

Figure 1a: Indexed cast

Figure 1b: Mold for duplication of master cast

Fabrication of acrylic resin test bases

The test bases were fabricated on the three duplicated casts using heat cure acrylic resin and processed according to the manufacturer's directions. The three test bases were designated as A_w, A_{50} and A_{100} as per the cast on which they were fabricated. The test bases were finished and polished, and a wire loop of 19 gauge orthodontic wire (K.C. Smith & co.) was placed on the centre of the vault, following intersection of the indices on the cast (Fig. 2) i.e. at a point of intersection of lines joining canine eminence and hamular notch (lines joining indices A to C and B to D). The loop was secured in position with the help of auto-polymerizing acrylic resin material.

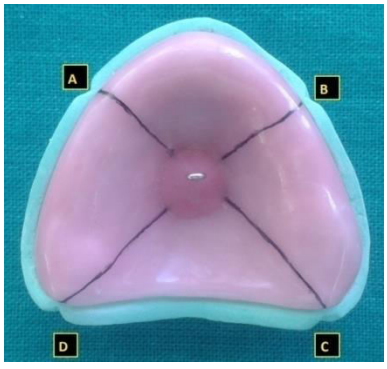

Figure 2: Fixation of wire loop

Measurement of retention of denture bases

Retention apparatus

A specially designed apparatus consisting of a metallic stand and a digital force gauge was used to measure retention values.

Stand consisted of a base, a vertical arm and a movable T-shaped assembly having two pulleys. Nylon thread was passed over these pulleys which were attached to denture base at one end and force gauge at other end. A rectangular metal tube with adjustable L-shaped extension having chin rest was attached horizontally to vertical tube which can move up and down with the help of screws (Fig. 3). Digital force gauge (Lutron FG 5000 A) with 3 types of display units: gram, Newton and ounce was used (Fig. 4). It had a measure capacity of 5000 g/176.40 oz. /49.03 Newton and overload capacity of 7000 g, high resolution, high accuracy, and peakhold.

Figure 3: Retention apparatus

Figure 4: Leutron FG-5000- Force gauge

Sandblasting the denture bases

The borders i.e. peripheral seal area and the posterier palatal seal area of the test bases (denture bases A_{50} and A_{100}) were first covered with tin foil to protect these areas from sandblasting (Fig. 5a). The test bases were held one inch away from the outlet of the sandblasting- machine with a line pressure of 4 Kg/cm^2. The basal surface of test bases A_{50} was uniformly sandblasted (Fig. 5b) with 50µ and A_{100} with 100µ alumina dust (Abrasive Alumina, Ugin Dentaire, France) for one minute by using a sandblasting Machine (Dentalfarm-Torino Itally).

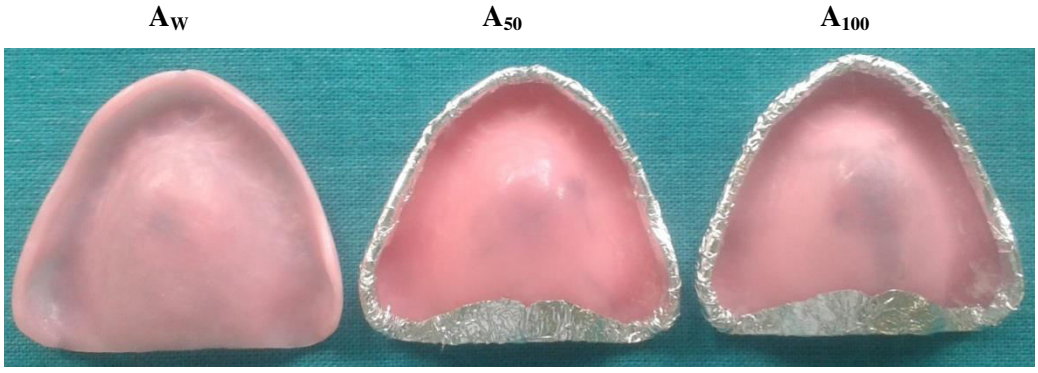

Figure 5a: Denture bases A_W, A_{50} and A_{100} (borders and PPS area of A_{50} and A_{100} covered with aluminium foil before sandblasting)

A_W A_{50} A_{100}

Fig. 5b: Denture base A_W (without sandblasting), A_{50} (after sandblasted with 50µ alumina) and A_{100} (after sandblasted with 100µ alumina)

Testing procedure

The patient was seated upright in front of the testing device in a comfortable position. The chin of the patient was placed quite firmly in the chin rest. The test denture base attached to nylon thread was rinsed thoroughly with water prior to insertion in the patient's mouth to minimize the variable factors of retention which could be influenced by a change of salivary content and firmly seated on the foundation. Force gauge attached to other end of the nylon thread was slowly pulled down in vertical direction until the denture base was dislodged and peak value was recorded (in grams) for all the three denture bases (denture bases A_W, A_{50} and A_{100}).

Figure 6: Testing procedure – retention of maxillary denture base being measured on the patient

Analysis of data

The dislodging forces for the three denture bases (A_W, A_{50} and A_{100}) of each subject were recorded (in grams) and the collected data was subjected to statistical analysis.

Results

The mean forces for the denture bases A_W, A_{50} and A_{100} were recorded; for A_W without air abrasion and for A_{50} and A_{100} after air particle abrading the basal surfaces with 50µ and 100µ alumina particles respectively (Table 1). One way ANOVA was used to compare the retention forces of test bases followed by post-hoc Tuckey's HSD test (Table 2 and 3).

DISCUSSION

The present in-vivo study was planned to determine the effect of surface treatment (air abrasion) of tissue surface of maxillary denture base on its retention. The objective was to evaluate and compare the retention of maxillary denture bases without and after surface treatment of basal surface with 50µ and 100µ alumina grit particle. It was observed that air particle abrasion of the basal surface significantly improved the retention of denture bases.

Polymethyl methacrylate (PMMA) is the most commonly used denture base material and its resistance to surface wetting due to its low surface energy has been realized.[14] Various attempts have been made to improve its wettability and retention by surface modification procedures like sandblasting basal surface of dentures, Durabond process (depositing an ultra thin layer of silicon dioxide-on the denture bases), titanium trichloride with hydrogen peroxide treatment and vacuum discharge method with low pressure water vapors and air mixture.[9,13,15,16,17,18] the devices used by previous investigators include: spring balances,[10] lever arm with loading apparatus,[15,19] Rhiele universal testing machine,[20] dial type push pull dynamometer,[11] strain guage force transducer[8,9] and hydraulic and electronic system using an extra oral transducer. Digital force gauge (Lutron FG 5000 A) with 3 types of display units: gram, Newton and ounce was used in this study. It had a measure capacity of 5000 g/176.40 oz. /49.03 Newton and overload capacity of 7000 g, high resolution, high accuracy, and peakhold.

The denture bases tested after sandblasting with 50 µ alumina grit sand showed 669.23gms increase in retention values, with percentage increase of 48.06%, in comparison to retention of denture bases without sandblasting. The p value was <0.001.

Table 1: showing mean forces for denture bases A_W, A_{50} and A_{100}

Patient No.	Mean Forces in grams		
	Without sandblasting (A_W)	**After sandblasting with 50 µ (A_{50})**	**After sandblasting with 100 µ (A_{100})**
1	1590	2282	2765.33
2	1162.67	1581.67	1948.67
3	1959	3372.33	3840.33
4	1399.67	1903.33	2236.67
5	1086.67	1596.67	1936.33
6	1999	2982.67	3715.67
7	876.667	1143	1503.67
8	1713.33	2661.33	3093
9	1648.67	2689.67	3235.67
10	1172.67	1573	1859
11	1038.33	1407.33	1856.67
12	1624.33	2569.67	2974.67
13	1271	1771.33	2101.33
14	831.667	1072.67	1431.67
15	1288.33	1967.33	2378.33
16	1451.67	2173.33	2499.33
17	1004.67	1413	1773.67
18	1492.67	2203	2734.67
19	1403.33	2091	2561
20	1835	2779.67	3346

Table 2: Shows statistical analysis of retention of maxillary complete denture bases using "one way ANOVA test"

Method	**No. of Cases**	**Mean ± S.D.**	**df**	**p value**	**Sig (2 tailed)**
Without sandblasting (A_W)	20	1392.467± 343.0774			
After sandblasting with 50 µ (A_{50})	20	2061.7±618.473	59	<0.0001	Sig
After sandblasting with 100 µ (A_{100})	20	2489.583±710.312			

Table 3: Shows statistical analysis retention of maxillary complete denture bases using "Post-hoc Tuckey's HSD test"

Sr. No.	**Method**	**No. of Cases**	**Mean ± S.D.**	**Diff in Means**	**p**	**Sig**
1.	Without sandblasting (A_W)	20	1392.467± 343.0774	669.233 (48.06%)	0.001	Sig
	After sandblasting with 50 µ (A_{50})	20	2061.7±618.473			
2.	Without sandblasting (A_W)	20	1392.467± 343.0774	1097.116 (78.79%)	0.001	Sig
	After sandblasting with 100 µ (A_{100})	20	2489.583±710.312			
3.	After sandblasting with 50 µ (A_{50})	20	2061.7±618.473	427.883 (20.75%)	0.061	NS
	After sandblasting with 100 µ (A_{100})	20	2489.583±710.312			

Retention of maxillary denture bases tested after sandblasting with 100 µ alumina grit sand in comparison to retention of denture bases without sandblasting showed an increase of 1097.11gms, with percentage increase of 78.79% and p value was <0.001. These results were statistically significant ($p<0.05$).

Increased retention of denture bases after sandblasting may be because of the fact that sandblasting produces a rough or a porous surface and encourages saliva droplets to be entrapped in these pores, which render the resin surface more hydrophilic. It also increases the relative surface area of the test bases. Consequently, more resistance will be offered by the meniscus to recede at the denture tissue interface as sandblasting increases the surface area of test bases. Sandblasting increases wettability of the denture bases by decreasing the advancing contact angle and receding contact angle.[17]

Retention of maxillary denture bases after sandblasting with 100 µ alumina grit sand % in comparison to retention of denture bases sandblasted with 50 µ alumina grit sand shows an increase of 427.88 gms with percentage increase of 20.75% and p value was 0.061. As difference in retention between group-A_{50} and A_{100} was insignificant, further studies are needed to investigate the retention of dentures following air abrasion with different particles alongwith microscopic evaluation of the basal surface.

As retention of a denture base was markedly improved by sandblasting. Thus, periodic modification of the basal surface with air-particle abrasion could be advantageous.[9]

A possible drawback of this procedure is that surface roughening may cause a mechanical irritation of the underlying soft tissues and adherence of microbes to fitting surface.[21,22,23] Therefore it is always advisable to strongly emphasize the importance of oral and denture hygiene in patients who wear air – abraded prosthesis.[13]

CONCLUSION

The results of this study indicated that air abrading the basal surface significantly improved retention of denture bases.

A modification of tissue surface of acrylic resin denture base by surface treatment methods show improvement in retention by increasing area of contact, and making them hydrophyllic and wettable.[9,15,17,18]

Therefore within the limitations of this study it was concluded that retention could be significantly increased after air abrading the denture bases and the technique may be recommended as an adjunctive measure for improving the retention of complete dentures in patients with resorbed ridges or in patients who complain of loose dentures which are otherwise well fitting and accurate. Air abrasion of the basal surface, as a method for improving complete denture retention needs further subjective evaluation in poor foundation cases to prove its validity.

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