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Improving the Adaptation of Maxillary Denture Base by Anchoring it to the Cast– An in Vitro Study

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KEYWORDS

denture base, cast, adaptation

ABSTRACT:

The present study is undertaken to investigate the accuracy of fit and adaptation of maxillary denture base to stone cast processed by the conventional method and other anchoring to cast methods. The palatal adaptation of maxillary denture bases to stone casts fabricated by conventional method and other anchoring to cast methods is investigated.

1. Introduction

Adhesion, cohesion and reduced atmospheric pressure all contribute to the retention of complete dentures. Craig et al stated that, retention of denture is generally depends on capillary forces. These forces are at maximum when the distance between the denture surface and supporting tissue is at minimum. Other factors, like area of coverage and occlusion is also involved, but the better the denture base conforms to the tissue surface the better is the retention.

Taylor & Kern stated that the liquid, methyl methacrylate shrinks as it polymerizes to polymethyl methacrylate, yielding a 21% decrease in the volume of the material. Such a large degree of shrinkage would obviously not allow any denture to fit properly.[1] Taylor, Peyton, Anusevice investigated that a trend of utilizing a mixture of polymethyl Methacrylate (PMM) powder and monomethyl Methacrylate (MM) liquid in a ratio of 3:1 by volume restricts the volumetric shrinkage to only 7%. [2,3] Polyzois L.G investigated that Warpage and distortion of the denture base that occur within the processing flask are exaggerated after the removal of the dentures from the master casts. This is mainly due to the relaxation of processing strains and usually can be observed at the posterior border of the maxillary cast.[4] In general, this Warpage follows a pattern: flanges draw inward in the lateral aspects of the tuberosities and for that denture base is raised from the palate and lack of adaptation in the posterior palatal seal area occurs. Therefore the present study is undertaken to investigate the accuracy of fit and adaptation of maxillary denture base to stone cast processed by the conventional method and other anchoring to cast methods.

2. Objectives

To investigate and compare the palatal adaptation of maxillary denture bases to stone (Type III gypsum, kalstone) casts fabricated by conventional method and other anchoring to cast methods.

3. Materials and Methods

Construction of metal die:

Dental stone is poured into edentulous maxillary rubber mold using manufacturer's recommended water powder ratio. A maxillary edentulous cast was obtained. Then all the unfavorable undercuts was removed from the stone cast. An identical metal die was prepared from that stone cast.

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Construction of Casts:

Fifteen alginate impressions were made from the metal die. Fifteen identical stone casts were obtained after pouring those impressions.

Marking of the cast:

Fifteen identical stone casts were grouped, each comprising of five casts. First group of five casts were marked as C-1, C-2, C-3, C-4 and C-5. Second group of five casts were marked as E-1, E-2, E-3, E-4 and E-5. The remaining five casts were marked as H-1, H-2, H-3, H-4 and H-5.

Construction of molds:

Could mold seal was applied overC-1 cast. A uniform thickness of cold cure base plate of the denture bearing area was made. Using C-1 cast with the base plate ten numbers of molds was prepared by flasking procedure. Those molds were marked as M-1, M-2, M-3, M-4, M-5, M-6, M-7, M-8, M-9, and M-10.

Cold cure acrylic base plate was extended to the posterior aspect or back edge of the C-1. Extension was 8 mm in depth and 15 mm in width. Using C-1 cast with extended base plate another five molds were prepared by flasking procedure and those molds were marked as M-11, M-12, M-13, M-14, and M-15.

Making of holes in the casts:

Holes were bored on five of fifteen identical stone casts which were previously marked as H-1, H-2, H-3, H-4 and H-5. Six holes (three on either side of the midline) were drilled anterior to the posterior palatal seal in the mid palatal area in each of the stone casts. Each hole had a depth of 10mm and diameter of 2mm.

Constructions of Heat cure Base Plate:

Packing Procedure:

Method A:

M1, M2, M3, M4 &M5 molds were packed by heat cure resin using C1, C2, C3, and C4 &C5 casts respectively.

Method B:

M11, M12, M13, M14 & M15 molds were packed by heat cure resin by using E1,E2,E3,E4 &E5 casts respectively.

Method C:

M6, M7, M8, M9 & M10 molds were packed by heat cure resin using H1, H2, H3, and H4 & H5 casts respectively

According to the manufacturer's (DPI heat cure resin) recommended procedure and as mentioned above the fifteen acrylic resin packed molds within clamped flask were cured, bench cooled. After deflasking fifteen casts with heat cured base plates are obtained.

Sectioning:

Those fifteen acrylic base plates with stone cast were sectioned transversely posterior to the second molar region by a low speed cutting machine. Water was used as coolant. After transverse sectioning, fifteen slice (3-4mm thickness) of casts attached with base plates were obtained. Then each slice was shortened by two cuts made sagitally, each on either side of the midline so that a block of 15mm width (7.5mm on each side of the midline) was obtained.

Measurements:

Gap between each cast and its denture base was measured by scanning electron microscope. In each sample gap was measured in three locations.

4. Results

The data were obtained by measuring the gap between the each cast and its denture base. In each methods (A, B & C) five samples were taken and in each samples three measurements were taken in three locations.

The data was tabulated and subjected to statistical analysis.

The results along with their analysis are shown in different tables.

For the statistical analysis, the following different formulas were used:

a) The **mean** of a set of values were calculated by the equation:-

$$Mean(\bar{x}) = \sum x/n$$

Where $\sum x$ = sum of the primary values.

n = number of observations.

b) **Standard deviation** was obtained by using the formula:-

$$SD = \sqrt{(\sum (x-x)^2/n)}$$

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Where x = variable

x = mean of variables.

n = number of observations.

Student 't' test:

Unpaired 't' test was performed with the help of the formula:-

$t_k = (\bar{x}_1 - x_2) / S.E. (x_1 - x_2)$

Where x_1 and x_2 are two averages.

S.E. $(x_1 - x_2)$ is standard error.

k = degree of freedom (d.f.) = $(n_1 + n_2 - 2)$

n_1 and n_2 being the sample size.

Another formula for the 't' test

$t_k = (\bar{x}_1 - x_2) / \sqrt{s_1^2 - s_2^2 / n}$ (when $n_1 = n_2 = n$)

n= sample size.

't' values thus computed is compared with the critical value of 't' at 5% level and if it is smaller than the critical value, it is treated as non –significant (p> 0.05). But if it exceeds the critical value at 5%, 1% or 0.1% level, it will be treated as significant at that level (i.e. significant at p< 0.05 or p< 0.01 or p< 0.001 i.e. significant at 5% or 1% or 0.1% level).

analysis of variance (ANOVA):

When groups are three or more, 'F' test is preferred to't' test. For this purpose the analysis of variance of data were made and ANOVA table prepared, from where variance ratio (V.R.) is found out. If this ratio is found to be significant, C.D. (critical difference) value is subsequently found out to compare individual means by using the formula.

C.D. = t_k X $\sqrt{2Msq/n}$

n= sample size.

Where Msq is mean sum of square. C.D. thus find out at 5%, 1% and 0.1% levels and are they are used to compare the group means and interaction means. (Table 1-7)

Table 1: List of Description of the methods and their name:

Name of the methods	Description of the methods
Method A	Procedure of packing of unaltered casts with unaltered molds
Method B	Procedure of packing of unaltered casts with altered molds
Method C	Procedure of packing of drilled casts with unaltered molds

Table 2 : Measurements of five samples (three in each) and their mean in method A:

Sample no.	**Readings**			Mean of the three readings
	1st	2nd	3rd	
1	0.256	0.255	0.255	0.2553
2	0.452	0.451	0.452	0.4517
3	0.563	0.563	0.563	0.5630
4	0.471	0.470	0.469	0.4700
5	0.550	0.550	0.552	0.5507

Table 3: Measurements of five samples (three in each) and their mean in method B:

Sample no.	**Readings**			Mean of the three readings
	1st	2nd	3rd	
1	0.217	0.216	0.216	0.2163
2	0.256	0.255	0.255	0.2553
3	0.310	0.311	0.309	0.3100
4	0.275	0.275	0.276	0.2753
5	0.305	0.305	0.305	0.3050

Table 4: Measurements of five samples (three in each) and their mean in method C:

Sample no.	**Readings**			Mean of the three readings
	1st	2nd	3rd	
1	0.012	0.012	0.012	0.0120
2	0.014	0.014	0.013	0.0137
3	0.016	0.015	0.015	0.0153
4	0.015	0.016	0.015	0.0153
5	0.013	0.013	0.013	0.0130

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Table 5: Measurements of averages, S.D., 95% confidence interval of the averages:

Methods	Sample size	Average	S.D.	C.V. (%)	95% confidence interval of the average
A	5	0.458	0.1234	26.94	0.403 – 0.513
B	5	0.272	0.0358	14.15	0.255 – 0.289
C	5	0.014	0.0014	10.33	0.013 – 0.015

Table 6: Comparison of the average values obtained from the three methods:

Difference Between The Methods	Difference in average	S.E. of the difference	Significance of the difference	
			't' value	'p' value
A-B	0.186	0.0578	7.92	P<0.001
A-C	0.444	0.0552	8.08	P<0.001
B-C	0.258	0.0172	14.97	P<0.001

Table 7: Analysis of variance (ANOVA) of data obtained from the three methods:

Source	Degrees of freedom (D.F)	Sum of squares	Mean of Sum of squares	'F' value
Between methods	2	0.49787	0.24894	44.70
Within methods	14	0.06682	0.00557	-
total	14	0.56469	-	-

5. Discussion

Woelfel J.B. et al evaluated complete dentures made with eleven different types of materials. They found acrylic resin to exhibit 0.19% to 0.42% linear shrinkage on curing when measurements were made in the intermolar (2nd molar to 2nd molar) region. [5,6]

Few studies are available regarding the improvement of the fit of the denture base by anchoring the base plate to the cast.

Polyzois G.L. investigated that anchoring methods improved the adaptation of denture bases by minimizing the discrepancy between the denture base and cast. The greatest discrepancies observed in all methods were at the central portion of the posterior palatal region. The gap was measured by a microscope with micrometer eyepiece. There was a significant difference ($p<0.05$) between the different methods. In our study difference between the different methods was highly statistically significant ($p<0.001$) and the gap was measured by most accurate microscope (SEM).

Sanders J.L. et al measured the gap between the record base and standard cast in five locations. In the ridge crests area the gap was less than 0.04 mm to 0.15 mm and in the half way between the midline and the ridge crests on each side had wide variations in measurement of discrepancies. Clinically there was no appreciable difference in the adaptation of the record bases in the mouth independent of different curing methods and the resin used. Study showed that there was statically significant ($p<0.01$) difference in adaptation between the different curing methods. [7] In our study the average gap was highest in method A. Method B records much lower average value in comparison to that of method A. Method C records lowest average. Unpaired't' test showed critical value of 't' with 8 degrees of freedom (d.f.) is 2.306, 3.555 and 5.041 at 5%, 1% and 0.1%

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probability levels. As all the 't' values exceed even in the 0.1% level, the difference in averages between the methods are highly significant ($p< 0.001$).

ANOVA study showed that as 'F' value is 44.70, the difference between the averages was highly significant.

C.D. (critical difference) values at 1% and 0.1% levels were 0.144 and 0.204 respectively. So as the difference of the averages between method A and method B is 0.186, it was significant at 1% level ($p<0.01$). The other two differences (A-C & B-C) having exceeded 0.204, they are both significant at 0.1% level ($p<0.001$ in both cases).[8-12]

6. Conclusion

Fifteen identical maxillary stone casts were prepared after taking fifteen alginate impressions from the metal die. Five of those casts were marked as C-1, C-2, C-3, C-4 and C-5, another five casts were marked as E-1, E-2, E-3, E-4 and E-5, remaining five casts was marked as H-1, H-2, H-3, H-4 and H-5. Uniform thickness cold cure base plate was adapted over the denture bearing area of C-1. Using C-1 with the base plate ten numbers of molds were prepared by flasking procedure. Cold cure base plate was extended to the posterior aspect of the C-1, again, using the cast with extended base plate another five molds were prepared by flasking procedure.

Among the previously made fifteen identical casts holes were drilled in posterior palatal seal area in five casts which were previously marked as H-1, H-2, H-3, H-4 and H-5. Five molds prepared by C-1 cast with unaltered base plate were packed by heat cure acrylic resin using five unaltered casts (C-1, C-2, C-3, C-4 and C-5) by method A, five molds which were prepared by C-1 cast with extended base plate were packed by heat cure acrylic resin using five unaltered casts (E-1, E-2, E-3, E-4 and E-5) by method B and another five molds prepared by C-1 cast with unaltered base plate were packed by heat cure acrylic resin using five drilled casts (H-1, H-2, H-3, H-4 and H-5) by method C. After curing, those fifteen casts with heat cure base plates (without removing the base plate from the cast) were sectioned transversely posterior to the second molar region. Again those casts with base plates were cut sagitally (either side of the midline) to obtain the smaller sample size having 15mm width and 3-4mm thickness.

The gap between each cast and its denture base in three different locations of the fifteen samples (prepared by method A, B and C) was measured by scanning electron microscope.

Average recoding of the gap of different location was determined in each sample. Thus average gap between cast and its denture base in method A was 0.458mm.The average gap between cast and its denture base in method B was 0.272mm.The average gap between cast and its denture base in method C was 0.014mm.

A correlation of these measurements was done by statistical analysis and it was found that:

a) S.D. of method A - 0.1234.

S.D. of method B - 0.0358.

S.D. of method C - 0.0014.

b) Student 't' test showed that difference of the averages are highly significant even at 0.1% level ($p<0.001$).

c)ANOVA test showed that difference of the averages between method A & B was significant at 1% level ($p<0.01$), difference of the averages between method A & C and B & C was highly significant, even at 0.1% level ($p<0.001$). 'F" value is 44.70.

The gap obtained by method C is minimum (0.014mm).

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