"A Comparative Evaluation of Palatal Adaptation in Denture Bases Processed With Compression Molding and Injection Molding In Two Different Palatal Configuration"-An In Vitro Study

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Abstract- The success and draw backs of the compression molding are well studied and reported but there is no enough studies or reports on injection molding. This study is on a comparison and evaluation of palatal adaptation of two different denture bases fabricated in two different palatal forms namely Shallow palate and Deep palate were used. Orientation notches (OrN) were made in the Master Model and were duplicated. 20 Shallow and 20 Deep palate cast were made. Denture bases were processed by Compression molding and Injection molding technique. The casts were trimmed in the PPS area and midline and the palatal adaptation was evaluated using vision measuring system. The results revealed that the mean palatal adaptation of injection molding denture bases was statistically significant when compared to compression molding denture bases in both the shallow palate and deep palate ($p \leq 0.05$). But there was no statistical difference within the injection molding and compression molding denture bases in both palates ($p \geq 0.05$). The Injection molding denture bases had better palatal adaptation. The material of choice and the technique of processing plays a major role than the shape of the vault in deciding the palatal adaptation of the denture.

Index Terms- Compression Molding, Injection Molding, Orientation Notches, Posterior Palatal Seal, Midline

I. INTRODUCTION

The success of the removable complete denture depends upon its retention, stability, and support. The retention of the complete denture is directly related to the adaptation of the base to the supporting oral tissues and is maximised when there is more intimate adaptation with the oral tissues. PMMA based acrylic resin have been used popularly for the denture bases.

In a clinical situation, decreased gap between the denture base and the tissue surface contributes to improved denture retention. Previous studies reported that variations in measurements from less than 0.25 to 0.27 mm in the fit of the record bases to the master cast would appear to have little clinical significance in the serviceability of dentures, because tissue displacement of only 0.25mm would be required to allow almost complete seating of a maxillary denture on the oral tissues[4].

Palatal adaptation of the denture is influenced by the material, the processing technique and the anatomic morphology of the vault also plays a role.

Two recognised changes are unavoidable in PMMA based acrylic resin which is Shrinkage and expansion[2]. However, newer denture materials and processing techniques are being introduced to reduce the shrinkage and expansion[3]. Volumetric shrinkage occurs during polymerisation process is due to the differences in densities of the monomer and the polymer, this results in a lifting of the denture base away from the posterior palate area after the polymerisation of PMMA.The conventional processing technique causes polymerization shrinkage, thermal contraction during flask cooling, and strain accompanying stress release during de-flasking may cause diminished adaptation of the denture to the tissues[4].

Assessment of the complete adaptation of the denture, along the posterior border is insignificant; adaptation of the denture base should be quantified or assessed along the antero-posterior region and the midline. The shallow palatal vault displays interface gap openings over a wider area at the posterior border of the denture extending from ridge to ridge. The V

shaped palatal forms usually seen in the deep vault have openings only in the midline.

The aim of the study was to compare the palatal adaptation of two different denture bases fabricated by compression molding and injection molding in two different palatal forms namely shallow and deep vault along the Midline, Posterior Palatal Area and the Entire arch.

I. Materials and Methods:

The impression of the stone cast was made with irreversible hydrocolloid material (Zelgan Plus, DENTSPLY) and it was poured with base plate wax (Hindustan Modelling Wax, Hindustan Dental Products).

The waxed cast was processed with Heat cure acrylic resin- Pink (Acrylin-H, Asian Acrylates) according to the manufacturers recommendations. Two master casts made of PMMA acrylic resin, one with the Shallow vault and the other with Deep vault were obtained (Fig 1 & Fig 2).

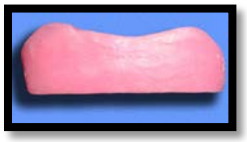

Fig 1 Master model – Shallow palate

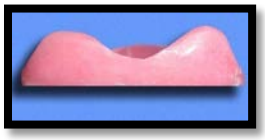

Fig2 Master Model – Deep palate

'V' shaped orientation grooves were made on the Master Model for both the Shallow palate cast and Deep palate cast. The Orientation Notches (OrN) were marked on 5 specific points namely in the Left Vestibule (LV), Left Ridge (LR), middle of the Posterior Palatal Seal (MPPS), Right Ridge(RR), Right Vestibule (RV) with a indelgible marker along the posterior palatal seal area. Three specific points namely Labial Frenum (LF), Anterior Ridge (AR) and in Mid Palatine Raphe (MPR) were marked along the midline. The Orientation notches of 2 mm were drilled using a stable surveyor with a handpiece (Fig 3).

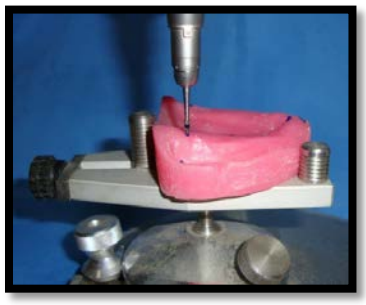

Fig 3 Drilling OrN in the cast

II.A Fabrication of special tray:

A single base plate wax (Hindustan Modelling Wax, Hindustan Dental Products) was adapted all around the master model as a single wax spacer[5]. The wax in the area of the retaining grooves was removed to maintain the orientation of the cast after the fabrication of the special tray. After the making of the spacer, the self-cure resin (Pyrax Rapid Repair, PyraxPolymers) was mixed and well adapted over the cast along with the spacer with uniform thickness.

Five pillars were made on the tray to orient the cast parallel to the floor. The parallelism was achieved by placing tray along with the pillars and the cast in the hydraulic pressure machine before the resin in the pillars was completely polymerised. Pressure was applied until the cast was parallel to the floor. The whole assembly was maintained until the pillars were completely polymerised (Fig 4).

Fig 4 special tray with Pillars

II.B Impression Procedure:

The spacer was completely removed and one relief hole was given in the centre of the palate which was greater than 1.0 mm[5]. After the spacer was removed, tray adhesive (Ivoclar Vivadent) was applied and then impression material was loaded uniformly on to the special tray (Aquasil Ultra Monophase Fast Set, Smart Wetting® Impression Material) and then the cast was placed within the tray and taken to the hydraulic bench press where a pressure of 5 KgF[6] (72 psi) was applied and the pressure was maintained until the material was completely set (Fig 5). When the pressure was applied , the excess material flowed through the relief hole and the borders of the tray.

Fig 5. 72 psi pressure for impression making

II. C Pouring the cast:

20 casts were fabricated for both the shallow vault and deep vault palatal forms using dental stone (Gyproc, Prevest Dentpro Limted).

II.D Grouping

They were subdivided into two Sub Groups namely A and B for both the group of 10 casts each for fabrication of denture bases by Compression Molding and Injection Molding. (Table 1)

Group 1: Shallow Palate (S)	Group 2: Deep Palate (D)
Total Cast : 20	Total Cast : 20

Sub Group A (SC)	Sub Group B (SI)	Sub Group A (DC)	Sub Group B (DI)
10 cast : Compression molding (C)	10 cast: Injection molding (I)	10 cast : Compression molding (C)	10 cast: Injection molding (I)

Table 1: Grouping the casts

II.E Wax Up For Denture Base Fabrication:

A single shellac base plate (Rolex base plate, Ashoo Sons Company) was well adapted. The base plate was well fused to the cast with a thin roll of wax around the borders of the cast completely. The base was carefully removed and checked for its thickness with a Vernier calliper (Baker SD 10 Vernier Calliper). The thickness was evenly maintained within 3 mm (Fig 6) for all the 40 casts .

Fig 6 Thickness is measured with caliper

II. FProcessing

II.F.1Compression Molding:

The denture bases were processed by Compression molding Technique using Heat cure denture base resin (Lucitone, DENTSPLY) in a thermal acryliser unit (Acryliser C-73, Confident Dental Equipments) . A bench press pressure of 3000 psi (Fig 7) was applied during the trial closure overnight.

Fig 7 Bench curing at 3000 psi in Bench press

The curing temperature of 74^0celsius was maintained for 2 hour and 100^0celsius was maintained for 1 hour[1].

II.F.2 Injection Molding:

The denture bases were processed using Hydraulic Bench Press and a pressure of 6 Pa (Fig 8) was maintained. The Heat cure resin (SR-IVOCAP, IVOCLAR VIVADENT) was injected through an injector at a constant pressure of 6 Pa. during the whole process. The curing temperature was maintained at 98 degree Celsius for 35 minutes.

Fig 8 Curing under constant pressure (6 pa)

II.G. Making of the matrix:

After the dentures were retrieved from the flask, the flash was trimmed off. The cast was covered with a cellaphon sheet and then held with the cast with the help of a rubber band and yellow type II dental stone (Gyproc, PrevestDentpro Limited) was poured to form a matrix over the denture base (Fig 9). Matrix helped in preventing the dislodgement of the denture base from the cast during the trimming and measurement[6].

Fig 9 Matrix in cross section

II.H. Trimming the Cast:

After the matrix was set, the cast was trimmed of up to the OrN in the cast were visible along the posterior palatal seal area (Fig 10 & 11). The readings were taken along the PPS area for palatal opening, after which the cast were trimmed along the sides to see the OrN along the midline (Fig 12 & 13) to study for the palatal opening.

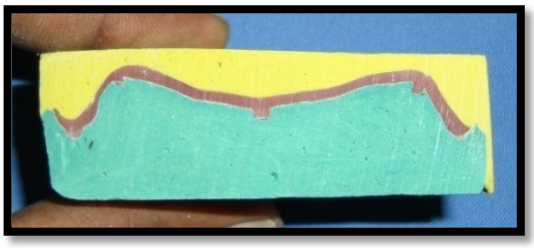

Fig 10 Trimming of cast to see OrN in Shallow palate

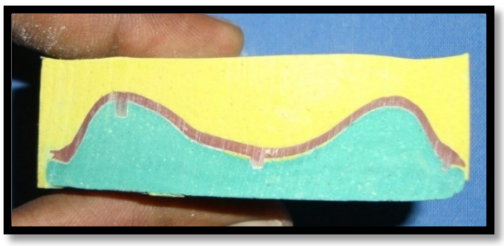

Fig 11 Trimming of cast to see OrN in Deep palate

Fig 12 OrN along the Midline for Shallow palate

Fig 13 OrN along the midline for Deep palate

II.I Data Collection:

Vision Measuring System (VMS) were used for recording the width of palatal opening. The VMS had an optical scanner which measured at 5x optical zoom. The readings were processed with the help of software (Msu25D Vision Measuring Software, 3 axis, Version 75.0 k) and produced on the computer screen (Fig 14 & 15).

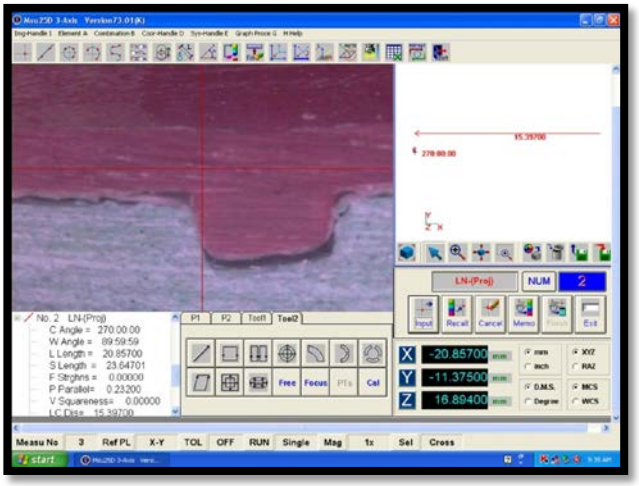

Fig 14 Processed image on the Screen for Compression molding denture base

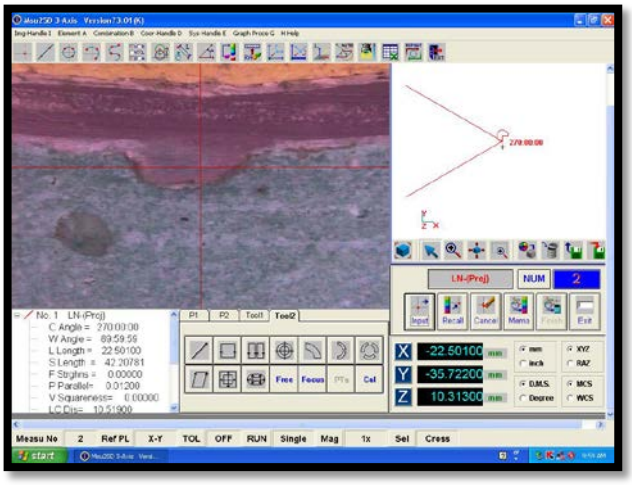

Fig 15 Processed image on the screen for Injection molding denture base

The results were subjected to statistical analysis with Independent Students't' test. Significance value (p) was found out using the Test of Significance.

III. RESULTS:

The results were tabulated in different tables for the PPS area, midline area and combined PPS and midline.

Between the groups of compression molding and injection molding in shallow and deep palate:

Along the posterior palatal seal:

(i) The mean palatal adaptation in shallow palate between compression molding and injection molding showed a high statistical significance. (Tables II).

(ii) The mean palatal adaptation in deep palate between compression molding and injection molding showed a high statistical significance. (Tables III).

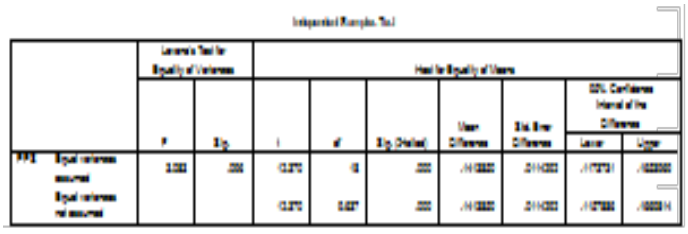

Table II: Test of significance for palatal adaptation along the PPS in shallow palate for compression molding and injection molding denture bases.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									99% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
PPS	Equal variances assumed	13.054	.002	15.388	18	.000	.1848200	.0120108	.1559863	.2100537
	Equal variances not assumed			15.388	9.833	.000	.1848200	.0120108	.1579998	.2116402

Table III: Test of significance for palatal adaptation along the PPS in deep palate for compression molding and injection molding denture bases

Along the midline:

(i) The mean palatal adaptation in shallow palate between compression molding and injection molding showed a high statistical significance. (Tables IV).

(ii) The mean palatal adaptation in deep palate between compression molding and injection molding showed a high statistical significance. (Tables V).

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
MID	Equal variances assumed	3.030	.099	12.927	18	.000	.1335500	.0103316	.1118542	.1552658
	Equal variances not assumed			12.927	9.581	.000	.1335500	.0103316	.1104026	.1567174

Table IV: Test of significance for palatal adaptation along the MIDLINE in shallow palate for compression molding and injection molding denture bases

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
MID	Equal variances assumed	9.299	.007	15.018	18	.000	.1785 3625	.01188789	.1535 6072	.2035 1178
	Equal variances not assumed			15.018	10.719	.000	.1785 3625	.01188789	.1522 8715	.2047 8535

Table V: Test of significance for palatal adaptation along the MIDLINE in deep palate for compression molding and injection molding denture bases

Entire arch:

(i) The mean palatal adaptation in shallow palate between compression molding and injection molding showed a high statistical significance. (Tables VI).

(ii) The mean palatal adaptation in deep palate between compression molding and injection molding showed a high statistical significance. (Tables VII).

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
SC - SI	Equal variances assumed	9.645	.006	8.917	18	.000	.15235500	.01708881	.11647274	.18827726
	Equal variances not assumed			8.917	9.228	.000	.15235500	.01708881	.11386352	.19084738

Table VI: Test of significance for mean palatal adaptation in shallow palate for compression molding and injection molding denture bases throughout the arch

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
DC - DI	Equal variances assumed	13.994	.001	15.681	18	.000	.18065875	.01152068	********	********
	Equal variances not assumed			15.681	9.615	.000	.18065875	.01152068	********	********

Table VII: Test of significance for mean palatal adaptation in deep palate for compression molding and injection molding denture bases throughout the arch

Results within the groups:

(i) The mean palatal adaptation between shallow and deep palate throughout the arch in compression molding showed no statistical significance. (Tables VIII).

(ii) The mean palatal adaptation between shallow and deep palate throughout the arch in impression molding showed no statistical significance. (Tables IX).

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
SC - DC	Equal variances assumed	.702	.413	-1.591	18	.129	-.0347500	.0201346	-.079282	.0101209
	Equal variances not assumed			-1.591	15.686	.132	-.0347500	.0201346	-.079820	.0103001

Table VIII: Test of significance for a compression molding denture base in shallow and deep palate

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
SI - DI	Equal variances assumed	.000	.999	-1.478	18	.157	-.0041912	.0028362	-.0101499	.0017674
	Equal variances not assumed			-1.478	17.852	.157	-.0041912	.0028362	-.0101535	.0017710

Table IX: Test of significance for an injection molding denture base in shallow and deep palate

IV. DISCUSSION

The current study compared the palatal adaptation between shallow and deep. Earlier studies suggested a statistical difference in palatal adaptation in dentures between the shallow palate and deep palate where the adaptation for the deep palate is significantly more than the shallow palate[7].

The results of one study showed that palatal adaptation along the posterior palatal seal and midline was of high statistical difference. The mean palatal adaptation for Injection molding denture base was statistically higher, when compared to the compression molding denture base[8]. Two main reasons were the Pressure and in Injection molding technique the resin was pushed through the flask continuously for the complete polymerization cycle.

In Compression molding technique after the material was packed in the flask, the flask was placed under the bench press overnight at 3000 psi. After the flask was retrieved from the bench press, transferred to the clamp, where the amount of pressure built up within the flask in the clamp was unknown. But in Injection molding the material slowly pushed in to the flask at constant pressure (6 Pa) until the polymerization was completed. Difference in this pressure increased the palatal adaptation between the two denture bases.

In Compression molding technique the material was packed within the flask and then the pressure was applied hence when there is polymerization shrinkage there was no excess unpolymerised material to compensate for the shrinkage. In Injection molding technique first the flask was held at a pressure and later the material was injected slowly into the flask at a constant pressure until the polymerization was completed. This slow injection of material at a constant pressure helped to compensate for the shrinkage of the material which has already happened.

The results of this study differed to results of previous studies[9, 10, 11, and 12].

Turck reported that there was no statistical difference in adaptation between compression molding, microwave and light activated techniques[13].

Previous studies have reported that there was difference in adaptation in a compression molding denture in shallow palate and deep palate, in which the adaptation was better in deep palate compared to the shallow palate. The palatal adaptation between the compression molding and injection molding dentures in a shallow palate and deep palate along the PPS and midline, the results observed to be higher with no statistical difference. The adaptation of a compression molding denture was better in shallow palate than the deep palate but was not statistically significant. There was no difference in adaptation between the injection molding denture bases in shallow and deep palate because of the continuous application of pressure.

In compression molding, in deep palate when pressure was applied, the excess pressure tends to escape along when pressure was stopped, whereas in shallow palate since there was no deep undercut (steep palate) the pressure tends to escape all throughout the palate.

Comparing the adaptation of the denture bases in shallow and deep palate between the compression molding and injection molding the results were highly statistically significant. However there was no statistical significant difference in adaptation in shallow or deep palates in both compression and injection molding technique.

McCartney reported that additional distortion of the denture base and associated effects on the occlusion stabilize within 24 hours after removal of the denture from the master cast. Beyond this time there will be further distortion caused by water sorption and continued stress release, but it is of a statistically insignificant magnitude and does not warrant delay in delivery of the denture[14].

This difference in adaptation is not attributed to the material composition between these two materials used in different fabrication technique[15]. O'toole studied whether the processing technique of acrylic resins affected their dimensional stability. Several curing methods were suggested to improve the quality of acrylic resin restoration. The methods include (1) bench curing (2) curing under a Coat of petroleum jelly, (3) curing in a monomer atmosphere and (4) curing under pressure in air and/ or under water[16]. But he found out that there was no difference after using all these methods.

Gap formation between the denture base and cast are generally attributed to polymerization shrinkage of the resin material and a tendency of cooling shrinkage toward the central area of the denture base, as well as to subsequent distortion caused by confinement of the surface topography of the alveolar ridge. Hence the greatest gap was always seen in the centre of the PPS area or the Vestibule area[17].These findings are also predictable with the results reported by Consani et al[18], who compared the posterior border gap of the denture base-cast sets sectioned transversally at each area of the canine, molar and posterior ends.

Latta in his study has reported that there was shrinkage in compression molding dentures before and after polymerization[19]. Lee in his study examined the adaptation accuracy of acrylic denture base processed using fluid-resin (PERform), injection-moldings (SRIvocap, Success, Mak Press), and two compression-molding techniques. The PERform and Mak Press produced significantly smaller maximum palatal gap dimensions than the other groups ($p<0.05$)[20].

CONCLUSION:

Injection molding is better compared to compression molding and the following conclusion can be derived.

1. In both the Palatal forms the Palatal adaptation of the Injection molding denture bases is much better compared to the Conventional Compression molding denture bases.
2. Individually both Injection molding and Compression molding performs in the same way in both the Shallow palate and Deep palate.
3. The Material of choice and the technique of fabrication play a bigger role than the shape of the vault in deciding the palatal adaptation of the denture.

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