A COMPARISON OF RETENTION STRENGTHS OF DENTURES PROCESSED BY COMPRESSION MOULDING AND INJECTION MOULDING TECHNIQUES USING TWO DIFFERENT FORMS OF DENTURE ADHESIVES MEASURED AT DIFFERENT TIME INTERVALS

Dr. Anusha maganti¹, Shashikala Jain², Himanshu Gupta³, Roshika Sudan⁴, Naveen Ambata⁵, Anurag Arya⁶
Department of Prosthodontics, crown and Bridge, Maharaja Ganga Singh Dental College and Research Center, Sriganganagar, Rajasthan, India
Email: padmavathi.maganti1995@gmail.com

ABSTRACT

Background: Compression molding of heat cured PMMA is a well-established technique for denture processing. The purpose of this study is to evaluate whether the adhesives used on the dentures processed by compression moulding & injection moulding techniques to improve complete denture retention are truly effective and able to increase denture adhesion to the mucosa covering the edentulous alveolar ridge of the maxillary dentures.

Materials & Methods: Selected subjects were divided into: Group 1- Control group without Denture adhesive for the dentures made of heat cured acrylic material by compression moulding technique. Group 2- Control group without Denture adhesive for the dentures made of flexible resins by injection moulding technique. Group 3- With denture adhesive powder at time interval of 10 min, 1 hr, 3 hr where the dentures are made of heat cured acrylic materials by compression moulding technique. Group 4- With denture adhesive paste at time interval of 10 min, 1 hr, 3 hr and the dentures are made of heat cured materials by compression moulding technique. Group 5- With denture adhesive powder at time interval of 10 min, 1 hr, 3 hr and the dentures are made of flexible resins by injection moulding technique. Group 6- With denture adhesive paste at time interval of 10 min, 1 hr, 3 hr and the dentures are made of flexible resins by injection moulding technique.

Results: The mean value for fix-on powder for 10 min, 1 hr, 3 hr is 14.76+1.57, 16.8+1.25, 18.7+1.37 respectively. The mean value for Superpolygrip denture adhesive powder for 10min, 1hr, 3hr is 16.67+1.61, 19.20+1.8, 20.93+1.41 respectively. That mean value for Fix-on paste for 10min, 1hr, 3hr is 16.79+1.68, 18.60+1.399, 20.74+1.62 respectively. The mean value for Superpolygrip denture adhesive paste for 10min, 1hr, 3hr is 19.47+2.09, 21.48+1.74, 23.36+1.65 respectively. The mean value for Fix-on powder for 10min, 1hr, 3hr is 16.47+1.47, 18.41+1.37, 20.30+1.21 respectively. The mean value for Superpolygrip denture adhesive powder for 10min, 1hr, 3hr is 18.49+1.80, 20.90+1.64, 22.59+1.23 respectively. The mean value for Fix-on paste for 10min, 1hr, 3hr is 18.62+1.67, 20.40+1.40,22.40+1.51respectively. The mean value for Fix-on powder for time intervals of 10min, 1hr, 3hr are 14.76+1.57, 16.85+1.25, 18.76+1.37 respectively. The mean value for Fix-on paste form denture adhesives with time intervals of 10min, 1hr, 3hr are 16.79+1.68, 18.60+1.39, 20.74+1.62 respectively. The mean value for Superpoligrip powder for time intervals of 10min, 1hr, 3hr are 16.67+1.61, 19.20+1.87, 20.93+1.41 respectively. The mean value for Superpoligrip paste form denture adhesives with time intervals of 10min, 1hr, 3hr are 19.47+2.09, 21.48+1.47, 23.36+1.65 respectively. The mean value for Fix-on powder for time intervals of 10min, 1hr, 3hr are 16.47+1.47, 18.41+1.37, 20.30+1.21 respectively. The mean value for Fix-on paste form denture adhesives with time intervals of 10min, 1hr, 3hr are 18.62+1.67, 20.40+1.40, 22.40+1.51 respectively. The mean value for Superpoligrip powder for time intervals of 10min, 1hr, 3hr are 18.49+1.80, 20.9+1.64, 22.59+1.23 respectively. The mean value for Superpoligrip paste form denture adhesives with time intervals of 10min, 1hr, 3hr are 21.37+1.86, 23.15+1.30, 25.10+1.41 respectively.
Conclusion: Cream-type denture adhesives are more effective than powder-type adhesives because of their lower initial viscosity and higher adhesive strength. In this study, the effects of denture adhesives were measured only through a 3-hour period. It is possible that they could provide some added retention and stability over long periods.

Key words: Denture adhesives, retention, Superpoligrip powder

I. INTRODUCTION

The quality of life may be compromised as a result of complete edentulism and wearing complete dentures due to the dentures’ poor stability and retention, especially, the mandibular dentures. Normally, alveolar bone resorption starts immediately and progresses rapidly within the first 3 to 12 months after teeth extraction. However, residual ridge resorption would continue at different rates throughout the patient’s life. Denture adhesives are known since the late eighteenth century, but they were mentioned in the literature and described by the American Dental Association in 1935.

In the glossary of prosthodontic terms, it has been described as a material used to make a denture adhere to the oral mucosa with physical and chemical interactions. This phenomenon occurs with two phases; ingredients of denture adhesive become swelling, getting viscous and sticky form by means of absorbing the water in the saliva and later, filling the gap between mucosa and denture.

Dentists who support the advocate position suggest that denture adhesives can facilitate clinical procedures, patient acceptance, and patient satisfaction. They suggest denture adhesives can be used to stabilize trial bases for accurate jaw relations and improve the accuracy of the trial denture try-in stage of denture fabrication.

Compression molding of heat cured PMMA is a well-established technique for denture processing. The presence of intimate contact and accurate fit of the denture base to the underlying mucosa is essential for achieving retention and stability, especially that complete dentures rely almost entirely on physical means for retention. Heat cured PMMA also suffers from some mechanical and physical problems such as low impact and fatigue strengths as well as low thermal conductivity and hardness.

Injection molding techniques using thermoplastic resins have gained popularity in recent years as they are free from residual monomer and porosities. The purpose of this study is to evaluate whether the adhesives used on the dentures processed by compression moulding & injection moulding techniques to improve complete denture retention are truly effective and able to increase denture adhesion to the mucosa covering the edentulous alveolar ridge of the maxillary dentures.

II. MATERIALS & METHODS

The present study was conducted on 20 subjects, who came to the Department of Prosthodontics, Maharaja Ganga Singh Dental College & Research Centre.

The inclusion criteria were complete maxillary edentulous arch, age group: 45-60 years and exclusion criteria were serious medical problems, neurological disorders, xerostomia, allergic sensitivity to any of adhesive materials, pre-cancerous lesions, oral submucous fibrosis and any other gross anomaly related to maxillofacial structure. The informed consent was obtained from each one of the selected subjects and they were divided into:

Group 1- Control group without Denture adhesive for the dentures made of heat cured acrylic material by compression moulding technique. Group 2- Control group without Denture adhesive for the dentures made of flexible resins by injection moulding technique. Group 3- With denture adhesive powder at time interval of 10 min, 1 hr, 3 hr where the dentures are made of heat cured acrylic materials by compression moulding technique. Group 4- With denture adhesive paste at time interval of 10 min, 1 hr, 3 hr and the dentures are made of heat cured materials by compression moulding technique. Group 5- With denture adhesive powder at time interval of 10 min, 1 hr, 3 hr and the dentures are made of flexible resins by injection moulding technique. Group 6- With denture adhesive paste at time interval of 10 min, 1 hr, 3 hr and the dentures are made of flexible resins by injection moulding technique.

A set of two complete dentures were fabricated for all the patients following the conventional and injection moulding technique. Border extensions were checked and corrected, occlusion was verified. After proper check of the dentures in the oral cavity the patients were instructed to maintain maximum, non-forced inter cuspation for 1 minute. After this time, and with the mouth open and the upper lip relaxed, the tip of dynamometer was
placed on the palate where a ring clasp is fixed in denture. Dislodging force was applied until the dentures detached - the maximum retention force was registered by the dynamometer. After recording retention of the maxillary dentures, one of the study adhesives was applied. The same amount of adhesive was used in all tests, distributing the material in three equivalent portions in the anterior and lateral zones, in compliance with the instructions of the manufacturers. The dentures were then placed in the mouth, and the patients were again instructed to maintain maximum, non-forced intercuspation for 1 minute at time intervals of 10 minutes, 1 hour, and 3 hours. After this time retention force (in newton) was again recorded by a dynamometer. This procedure was repeated three times for each product without adding further amounts of adhesive, and waiting one minute in occlusion after each measurement. The same procedure as described above was repeated with the next product. The order of application of the adhesives was randomized, and all measurements were made by the same investigator. Thus, each patient was subjected to six measurements of retention strength including two control groups with four measurements.

### III. RESULTS

Results were assessed statistically. P value less than 0.05 was considered significant (P< 0.05).

Table 1: Comparison between the two denture adhesives in the powder form in given time using (Compression moulding technique)

<table>
<thead>
<tr>
<th>Time interval</th>
<th>GROUPS</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>T</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 MIN</td>
<td>FIXON(A1)</td>
<td>20</td>
<td>14.7600</td>
<td>1.57460</td>
<td>-3.793</td>
<td>.001*</td>
</tr>
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<td></td>
<td>POLYGRIP(B1)</td>
<td>20</td>
<td>16.6750</td>
<td>1.61828</td>
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<td></td>
</tr>
<tr>
<td>1 HOUR</td>
<td>FIXON(A1)</td>
<td>20</td>
<td>16.8550</td>
<td>1.25718</td>
<td>-4.650</td>
<td>.000*</td>
</tr>
<tr>
<td></td>
<td>POLYGRIP(B1)</td>
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<td>19.2050</td>
<td>1.87798</td>
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<tr>
<td>3 HOUR</td>
<td>FIXON(A1)</td>
<td>20</td>
<td>18.7650</td>
<td>1.37775</td>
<td>-4.919</td>
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<td>POLYGRIP(B1)</td>
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<td>20.9350</td>
<td>1.41208</td>
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</table>

Table 1 above shows the comparison between the two denture adhesives in the powder form in given time intervals on dentures processed by Compression moulding technique. The mean value for fix-on powder for 10 min, 1 hr, 3 hr is 14.76±1.57, 16.8±1.25, 18.7±1.37 respectively. The mean value for Superpolygrip denture adhesive powder for 10min, 1hr, 3hr is 16.67±1.61, 19.20±1.8, 20.93±1.41 respectively. It was observed that there was a significant difference in mean values for all the values among the two groups.

Graph I: Comparison between the two denture adhesives (PASTE FORM) in the given time using compression moulding technique

Graph I shows that mean value for Fix-on paste for 10min, 1hr, 3hr is 16.79±1.68, 18.60±1.399, 20.74±1.62 respectively. The mean value for Superpolygrip denture adhesive paste for 10min, 1hr, 3hr is 19.47±2.09,
21.48±1.74, 23.36±1.65 respectively. It was observed that there was a significant difference in mean values for all the values among the two groups.

Table 3 Comparison between the two denture adhesives (POWDER FORM) in the given time using injection moulding technique

<table>
<thead>
<tr>
<th>POWDER</th>
<th>GROUPS</th>
<th>Mean</th>
<th>SD</th>
<th>T</th>
<th>Sig.</th>
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</thead>
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<td>1.47759</td>
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<td></td>
<td>POLYGRIP(B1)</td>
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<td>1.80743</td>
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<td>1 HOUR</td>
<td>FIXON(A1)</td>
<td>18.4150</td>
<td>1.37239</td>
<td>-5.201</td>
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<td>20.9050</td>
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<td>3 H0UR</td>
<td>FIXON(A1)</td>
<td>20.3050</td>
<td>1.21416</td>
<td>-5.907</td>
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<td>22.5900</td>
<td>1.23241</td>
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Table 3 shows that the mean value for Fix-on powder for 10min, 1hr, 3hr is 16.47±1.47, 18.41±1.37, 20.30±1.21 respectively. The mean value for Superpolygrip denture adhesive powder for 10min, 1hr, 3hr is 18.49±1.80, 20.90±1.64, 22.59±1.23 respectively. It was observed that there was a significant difference in mean values for all the values among the two groups.

Graph 2 Comparison between the two denture adhesives (PASTE FORM) in the given time using injection moulding technique

Graph II shows that the mean value for Fix-on paste for 10min, 1hr, 3hr is 18.62±1.67, 20.40±1.40, 22.40±1.51 respectively. The mean value for Superpolygrip denture adhesive paste for 10min, 1hr, 3hr is 21.37±1.86, 23.15±1.30, 25.10±1.41 respectively. It was observed that there was a significant difference in mean values for all the values among the two groups.

Table 4 Comparison between the two denture adhesives forms (powder and paste) in the given time using Compression moulding technique

<table>
<thead>
<tr>
<th>FIXON</th>
<th>CONSISTENCY</th>
<th>Mean</th>
<th>SD</th>
<th>T</th>
<th>Sig</th>
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<tbody>
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<td>10 MIN</td>
<td>POWDER(A1)</td>
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<td>1.57460</td>
<td>-3.935</td>
<td>.000*</td>
</tr>
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<td>PASTE(A2)</td>
<td>16.7900</td>
<td>1.68645</td>
<td></td>
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</tr>
<tr>
<td>1 HR</td>
<td>POWDER(A1)</td>
<td>16.8550</td>
<td>1.25718</td>
<td>-4.160</td>
<td>.000*</td>
</tr>
</tbody>
</table>
Table 5 shows that the mean value for Fix-on powder for time intervals of 10min, 1hr, 3hr are 14.76+1.57, 16.85+1.25, 18.76+1.37 respectively. The mean value for Fix-on paste form denture adhesives with time intervals of 10min, 1hr, 3hr are 16.79+1.68, 18.60+1.39, 20.74+1.62 respectively. It was observed that there was a significant difference in mean values for all the values among the two groups.

Graph 3 Comparison between the two denture adhesives forms (powder and paste) in the given time using Compression moulding technique

Graph 3 shows that the mean value for Superpoligrip powder for time intervals of 10min, 1hr, 3hr are 16.67+1.61, 19.20+1.87, 20.93+1.41 respectively. The mean value for Superpoligrip paste form denture adhesives with time intervals of 10min, 1hr, 3hr are 19.47+2.09, 21.48+1.47, 23.36+1.65 respectively. It was observed that there was a significant difference in mean values for all the values among the two groups.

Graph 4 Comparison between the two denture adhesives forms (powder and paste) in the given time using Injection moulding technique.
Graph 4 shows that the mean value for Fix-on powder for time intervals of 10min, 1hr, 3hr are 16.47±1.47, 18.41±1.37, 20.30±1.21 respectively. The mean value for Fix-on paste form denture adhesives with time intervals of 10min, 1hr, 3hr are 18.62±1.67, 20.40±1.40, 22.40±1.51 respectively. It was observed that there was a significant difference in mean values for all the values among the two groups.

### Table 5 Comparison between the two denture adhesives forms (powder and paste) in the given time using injection moulding

<table>
<thead>
<tr>
<th></th>
<th>SUPERPOLYGRIP</th>
<th>CONSISTENCY</th>
<th>Mean</th>
<th>SD</th>
<th>T</th>
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<td>10 MIN</td>
<td>POWDER(B1)</td>
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<td>1.80743</td>
<td></td>
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<td></td>
<td>PASTE(B2)</td>
<td>21.370</td>
<td>1.86860</td>
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<td>1 HR</td>
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<td>1.41161</td>
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</table>

Table 5 shows that the mean value for Superpoligrip powder for time intervals of 10min, 1hr, 3hr are 18.49±1.80, 20.9±1.64, 22.59±1.23 respectively. The mean value for Superpoligrip paste form denture adhesives with time intervals of 10min, 1hr, 3hr are 21.37±1.86, 23.15±1.30, 25.10±1.41 respectively. It was observed that there was a significant difference in mean values for all the values among the two groups.

### IV. DISCUSSION

Retention is defined as ‘that quality inherent in the prosthesis which resists the force of gravity, adhesiveness of foods, and the forces associated with the opening of jaws’. The denture retention is one of the most difficult problems confronting the Prosthodontist. Successful denture therapy can be judged by its ability to withstand the occlusal forces, retention, and stability. The satisfaction level of patients is difficult to achieve. Even complete dentures with all the desired properties may fail to fulfill all the required criteria for the patient.7

Complete denture retention plays the most important role in patient satisfaction and long-term denture success.8 Usually, denture retention is governed by (1) the size of denture base area, (2) quality and quantity of saliva (thick ropy/thin watery), (3) adhesive and cohesive forces, (4) interfacial surface tension and capillarity, (5) presence and amount of bony undercut, and (6) height/width and shapes of remaining alveolar ridge.9

In this study beading of final impression was done to preserve width and height of sulcus in a cast and boxing is done to obtain a uniform smooth well shaped base of the cast. Beading and boxing of final impressions before pouring preserves the extensions, as well as the thickness, of the border; controls the form and thickness of the base of the cast; and boxing also facilitates placing remounting plates in the cast; and conserves artificial stone. It ensures the capture of the mucobuccal and mucolingual borders of impression. Beading and boxing the impression can facilitate to pour a base on the secondary impression without inverting.10

Agar was used to duplicate the master cast in the present study. Reversible hydrocolloid is most commonly used duplicating material in dentistry. Agar duplicating material is reversible and has adequate strength and elastic properties to make duplication of minor undercuts possible and an accurate cast may be obtained.11

In the study the dentures were cured using compression moulding and injection moulding technique. The conventional method is the most applicable method for curing acrylic resin due to its simplicity and relatively good accuracy. Therefore, in various studies this method has been considered the gold standard for comparison with other techniques. Among denture processing methods, injection molding has always been interesting for researchers because of compensation of polymerization shrinkage due to the pressure exerted by injection of the polyamide resin.

Even though compression moulding technique is widely used for the fabrication of acrylic complete dentures, this technique has some significant disadvantages such as increased vertical dimension, higher porosity, spherical deformation, higher acrylic shrinkage, inaccurate fit of the material to the master cast & larger amount of residual monomer. All these disadvantages could be eliminated by using an injection molding system.12

The results of the study showed all the denture adhesives used in the study had improved the retention of the dentures when compared to control group (without denture adhesives). As mentioned above the denture...
adhesives used in the study i.e Fix-on (powder& paste) mainly composed of carboxymethylcellulose as their main ingredient & Superpoligrip (powder & paste) composed of carboxymethylcellulose & polyvinylmethyl ether/ maleic acid as their main ingredient. CMC has higher solubility and provides a strong initial hold, but it dissolves quickly and loses its effectiveness within a relatively short period. PVMMA is less soluble, allowing it to play a positive role later and last for longer.

Hence our findings suggest that cream-type denture adhesives are more effective than powder-type adhesives because of their lower initial viscosity and higher adhesive strength. Jay shah et al13 in their studies found that the paste form of adhesive materials is more resistant to dislodgement compared to the powder form. In this study, the effects of denture adhesives were measured only through a 3-hour period. It is possible that they could provide some added retention and stability over long period and the effect of denture adhesives were not measured after drinking water and having food. Jillan-Minhan et al14 conducted a study on clinical evaluation of denture adhesives where he stated the patients feel the use of denture adhesives improve the chewing ability. Mujahed T. Qasim15 conducted astudy on the effect of two denture adhesives on maxillary complete denture dislodgement where he stated that use of denture adhesives improves the mastication. The sticky mass produced when a fixative combines with the saliva is difficult to remove from the mouth and the denture and may provide a medium to support bacterial growth a possibility which will be reduced by good oral and denture hygiene.

V. CONCLUSION

Our findings suggest that cream-type denture adhesives are more effective than powder-type adhesives because of their lower initial viscosity and higher adhesive strength. In this study, the effects of denture adhesives were measured only through a 3-hour period. It is possible that they could provide some added retention and stability over long periods. Likewise, these results are based on only two products of different forms and obviously, the data should not be extended as applicable to other products available.

REFERENCES