COMPARISON OF RETENTION OF MAXILLARY COMPLETE DENTURES, FABRICATED BY CONVENTIONAL MOLDING TECHNIQUE AND INJECTION MOLDING TECHNOLOGY

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ABSTRACT:

Background: Many aspects of Prosthodontics treatment; be that clinical or laboratory based, may impact on overall patient satisfaction and the clinical success of treatment. This study was conducted to compare the retention of maxillary complete dentures, fabricated by conventional molding technique and injection molding technology.

Materials & methods: This study was conducted in the Department of Prosthodontics including Crown and Bridge in Maharaja Ganga Singh Dental College and Research Center, Sriganganagar. Inclusion criteria: Twenty completely edentulous patients seeking prosthodontic rehabilitation were randomly selected as test subjects in the age group of 45-60 years. Patient selection and impression making was carried out. Cast was prepared. All the samples were divided into two study groups as follows: Group A- Compression moulding and Group B- Injection moulding. INVESTING, PROCESSING OF DENTURES was done. After wards, there was preparation of the dentures for checking the retention followed by measuring the retention of dentures. The device was adjusted to display the readings in kgf. Statistics was done using SPSS version 21.

Results: Overall mean value of all the reading of the study group A is 5.93±0.39. Overall mean value of all the reading of the study group B is 6.29±0.45. It was observed that there was a significant difference in mean values for values among the two groups (p value of <0.001).

Conclusion: Maxillary dentures processed by injection moulding technique showed higher mean values of denture retention as compared to dentures processed by compression moulding technique. The dentures made by both the techniques showed acceptable retention on clinical examination.

Key words: Compression molding technique, denture, investing

I. INTRODUCTION

Many aspects of Prosthodontics treatment; be that clinical or laboratory based, may impact on overall patient satisfaction and the clinical success of treatment. 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 acrylic resin have been used popularly for the denture bases.¹³

In a clinical situation, decreased gap between the denture base and the tissue surface contributes to improved denture retention. Palatal adaptation of the denture is influenced by the material, the processing technique and the anatomic morphology of the vault also plays a role. Polymethyl methacrylate (PMMA) has been the most popular material used for denture fabrication since its introduction in 1937. Nylon is a crystalline polymer, whereas PMMA is amorphous. Two recognised changes are unavoidable in PMMA based acrylic resin which is Shrinkage and expansion. However, newer denture materials and processing techniques are being introduced to reduce the shrinkage and expansion.⁴⁵
Many factors in the laboratory procedures can lead to alteration of the occlusion during the construction of complete dentures. These factors are related to intrinsic characteristics of the materials and techniques and extrinsic potential errors made by the dental technician or dentist. Many physical forces and factors have been credited for enhancing retention, e.g., atmospheric pressure, vacuum, adhesion, cohesion, wettability, surface roughness, gravity, surface tension, viscosity, base adaptation, peripheral seal and muscular control.\textsuperscript{6} 

Retention is in direct proportion to viscosity of the saliva, denture surface area and the velocity of the dislodging force. Good adhesive and cohesive forces aid to enhance interfacial surface tension. Also, it decreases with increase in the width of the space between the denture base and the mucosa according to Stefan's law. Denture retention is therefore a dynamic issue as it mostly depends on factors controlling the flow of the interposed fluid.\textsuperscript{6,7}

The better the fit to the tissue, and the better the linear extent of the seal at the border, the better the denture will resist short term displacing forces. Brill's analogy of a piston in a cylinder of water offers a partial description of the fluid dynamics of the border seal but without alluding to the compliant behaviour of the soft tissues (ie when the pressure in the denture-mucosa space drops), which is relevant at least when the denture is first fitted. Ultimately, the central factors for the success of a denture depend primarily on the quality of the fit of the denture to soft tissue.\textsuperscript{6-8} This in turn hinges on the impression technique and subsequent denture base design and fabrication. All the above discussion leads to the factors that are known for the retention enhancing properties along with physical properties. Hence, in this study, a force gauge/dynamometer was used to evaluate the effect of processing techniques on the retention of the denture. This study was conducted to compare the retention of maxillary complete dentures, fabricated by conventional molding technique and injection molding technology.

\section*{II. MATERIALS & METHODS}

This study was conducted in the Department of Prosthodontics including Crown and Bridge in Maharaja Ganga Singh Dental College and Research Center, Sriganganagar. Inclusion criteria: Twenty completely edentulous patients seeking prosthodontic rehabilitation were randomly selected as test subjects in the age group of 45-60 years.

Patients with:-

1. Well formed alveolar ridges including proper height and thickness.
2. No severe undercuts or bony exostosis.
3. Firm mucosa of moderate thickness all over the denture bearing area and with no signs of inflammation, ulceration or hyperplasia was selected.

Exclusion criteria included Patients with-

1. Excessive ridge resorption
2. Fibrous anterior ridge
3. Papillary hyperplasia
4. Poor neuromuscular control
5. Rigid musculature and mucosal tissue (scleroderma, sub-mucous fibrosis).
6. Any other gross anomaly related to maxillofacial structure.

Patient selection and impression making

- The study group included male and female maxillary edentulous patients, aged 45-60 years with no pathological changes in the denture bearing area and with indications of prosthetic treatment with a complete maxillary acrylic denture.
Every patient signed an informed consent after being informed of the purpose, way of conducting, expected results and the potential risks, related to the research.

For each patient, primary impression (DPI) of the maxillary arch was made in a suitable sized stock tray and poured in dental plaster (MODEL PLASTER) to obtain the primary cast.

The cast was properly outlined and relieved for fabrication of custom impression trays using autopolymerizing acrylic resin (PYRAX).

The Custom trays were tried in the mouth and peripheries reduced so that they were 0.5 mm short of the tissue reflection.

Wax spacer was removed and tray adhesive was applied on the inner surface of tray and 2-3 mm outside the borders of tray.

After the adhesive (3M ESPE) had dried up, the base and catalyst pastes of polyether impression material (3M ESPE) were mixed and loaded in the tray and across the posterior palatal seal area including all borders.

Labial/buccal borders and posterior palatal seal were molded. The trays were removed after the impression material had completely polymerized and the borders were examined for their extensions. Excess material was trimmed off using a sharp Bard Parker blade.

**PREPARATION OF THE CAST**

The denture impression and the border molded tray were put on a platform and points were marked, 2mm below highest point of the border along the periphery with the help of metal scale and permanent ink and all those points were joined to form a line.

A beading wax was then placed along the line to achieve 2mm uniform border. The impressions were boxed, and the casts were poured.

Cast were duplicated using the reversible hydrocolloid material, agar (UNIDENT) and were divided into two groups.

**DIVIDING THE SAMPLES INTO GROUPS**

Sample of 40 dentures were divided into two categories:

Group A (n=20)- Compression moulding

Group B (n=20)- Injection moulding

Occlusion rims were made and then first maxillary rim was put in patients mouth and the plane was modified according to patients measurements. Then mandibular arch was placed in patients mouth and the VDO was recorded. Patient was asked to close his mouth by placing mandible in the most retruded position, hence centric relation was recorded. Teeth setting was done and it was checked in patients mouth again.

**INVESTING, PROCESSING OF DENTURES**

In GROUP A, for the first 20 samples the casts along with the Try in cold cure dentures were invested in the base of the dental flask No -7 with Type II dental plaster (DENTSPLY), the denture base was sealed to the master cast with molten modelling wax in order to prevent displacement.

Separating medium (PYRAX) was applied and the second pour was done with Type II dental plaster (DENTSPLY). The flask was clamped and plaster was allowed to set. Once the plaster was set the flask clamp assembly was immersed in boiling water in a dewaxing unit (UNIDENT) for 5 min.
The flask was opened and the molten wax along with the denture base was removed completely by keeping the flask under running hot water. A single layer of separating medium (PYRAX) was applied to the master cast, double thickness separating medium was applied to the mold space when the mold and cast was still warm but not hot as it may break the continuity of the separating film.

All the samples were invested, packed, bench cured and processed according to manufacturer’s instructions. For the group A heat cure polymer and monomer (PYRAX) was mixed with polymer monomer ratio of (23.4 gm: 10 ml) in an acrylic mixing jar (DELTA).

The acrylic dough was packed into the mold space and the flask was closed with 80 lbs pressure in a hydraulic press (UNIDENT) for 5 min. The flask was clamped and kept for bench curing for 30 min.

The denture bases were processed in a acrylizing hot water bath (POLYBATH, DELTA). The closed flasks were placed in room temperature water, heated up to 100 °C and was allowed to boil for 45 min. Once polymerized, the flasks were allowed to cool down to room temperature followed by keeping under running tap water.

In GROUP B samples, the next 20 casts were processed with injection moulding technique. The samples along with the Try in dentures were invested in the base of the dental flask (DR SMITH) with Type II dental plaster (DENTSPLY), the denture base was sealed to the master cast with molten modelling wax in order to prevent displacement.

The flask was then placed in boiling water for 6 min. The flask was opened and all residual wax were removed using boiling water. Cold mold seal (PYRAX) was applied to all gypsum surfaces and the flask was then allowed to cool to room temperature.

The flask assembly was then attached according to manufacturers instructions for injection moulding procedure. The acrylic resin (DR SMITH) cartridge was placed in the injection moulding unit and was heated at 295 °c for 15 minutes.

The flask was placed in the injection unit, and the acrylic resin was injected into the mold. The flask was removed from the injection unit for bench curing. The flask was kept for bench curing for 30 min prior to curing.

It is allowed to air cool for approximately 30 min, then the flask was placed in a lukewarm water bath to cool completely. The deflasking procedure was done once the flask reached room temperature.

**PREPARATION OF THE DENTURES FOR CHECKING THE RETENTION**

Dentures were waxed on each cast and coded. A loop made up of 19 gauge stainless steel wire were attached to anterior palatal region of the waxed up bases approximately corresponding to a line joining the distal surfaces of cuspids.

The finished dentures were inserted, checked in the mouth with pressure indicating paste, and adjusted as necessary.

**MEASURING THE RETENTION OF DENTURES:**

A digital force gauge (PRECISE SF -500) was used to record the retention of the maxillary complete dentures which were fabricated by compression and injection moulding techniques. The device was adjusted to display the readings in kgf. Statistics was done using SPSS version 21. Descriptive statistics (mean, standard deviation values), analysis of variance (ANOVA) and Shapiro–Wilk test (a test of normality in frequentist statistics) were used. The results were designated as “statistically significant” at p-value < 0.01

**III. RESULTS**

Overall mean value of all the reading of the study group A is 5.93±0.39. Overall mean value of all the reading of the study group B is 6.29±0.45. It was observed that there was a significant difference in mean values for values among the two groups (p value of <0.001).
We suggest a standard for dislodging force of maxillary complete denture fabricated by compression molding technique and a standard for dislodging force of maxillary complete denture fabricated by injection molding technique technology. The injection molding technique was found to produce better fitting maxillary complete denture when compared to compression molding technique. This would ensure better retention, less traumatic manifestations after insertion and higher patient comfort.

### Table 1: Comparison of mean values among both the study groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
<th>95% CI (Lower-Upper Bound)</th>
<th>t test</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>5.93</td>
<td>0.39</td>
<td>-0.799 to 0.079</td>
<td>4.06</td>
<td>0.007*</td>
</tr>
<tr>
<td>Group B</td>
<td>6.29</td>
<td>0.45</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*: statistically significant

**Fig 1:** Primary impression; **Fig 2:** Secondary impression; **Fig 3:** Intraoral photo of maxillary residual ridge; **Fig 4:** Reading noted for conventional technique processed denture; **Fig 5:** Reading noted for injection moulding processed denture

### IV. DISCUSSION

In the present in vitro study the factors such as denture surface area could be eliminated because we explore two dentures which were made on duplicate casts for one and the same patient so these factors remain one and the same for both dentures fabricated by both technologies. So we assume that the interfacial surface tension and capillarity depend predominantly on the width of the space between the denture base and the mucosa. Perfect adaptation between the tissues and the denture base would suggest smaller space between tissues and impression surface of the denture, greater interfacial surface tension and capillarity, respectively better adhesion and retention of the maxillary complete denture.

Denture retention denotes the force required to completely remove a denture from its basal seat. Influence of adhesive and cohesive forces, surface tension, atmospheric pressure, viscosity and volume of saliva, and gravity on denture retention has been demonstrated. Denture retention by air depression between the denture and the...
mucosa could not be long-lasting because constant elasticity is not the histophysiologic feature of the mucosa. A sufficient layer of saliva is essential for retention as a result of physical effects.9

Many models have been devised to determine the relative importance of various physical factors that act through the salivary film at the denture-tissue interface. Denture retention is understood to be a function of saliva surface tension, its viscosity, the thickness of the salivary film, the contact surface, and the saliva denture contact angle. One of the consequences of the surface tension of liquids is the tendency to minimize the area of the free surface, generating the familiar curved surfaces of raindrops and menisci. The mere existence of a curved surface generates a pressure difference across that surface. If the surface is convex (which is described as a positive total curvature) the pressure is higher within the drop than without — therefore, positive pressure. If the total curvature is negative, such as for the ‘waisted’ shape of a drop held between one’s fingertips, the pressure is negative. This is the crucial point: that negative pressure exerts a force tending to draw the fingertips together. This is the force that retains two wet microscope slides together against a straight pull (not a sliding action). At the edge is a very thin film of water, with a large negative curvature because the separation of the slides is small, thus the force is great.10–13

Since oral mucosal tissues contain both the major and minor salivary glands, it is very difficult to attain or maintain a dry field when making impressions to capture the mucosal details of the edentulous arches. When using polyvinylsiloxanes, moisture control remains a critical factor for the predictable success of the clinical impression. However, polysulfide and polyether impression materials, because of their more hydrophilic nature, should be more compatible with the inherent moisture of the edentulous arch mucosal tissues. Even though there is a need to control the salivary secretions when making impressions with polysulfide rubber Polyether produced the best detail under moist conditions. The hydrophilic structures present in the polyether impression material are represented by carbonyl (C=O) and ether (C–O–C) groups, while polysulfide impression material contains hydrophilic disulfide and mercaptan groups (–S–H). The chemical structures containing available functional groups attract and interact with water molecules through hydrogen bonding.14,15

The flow of polyether rubber may increase the detail, but some authors question the need for precise surface detail for retention of a mandibular denture. Close adaptation to the tissue is usually considered necessary to increase retention and stability, but there may be a fine line where optimum adaptation ends and the pressure begins. The degree of detail that needs to be recorded by an impression for a complete denture has never been established. However, since viscosity is controlled and an adequate flow is maintained during seating in the mouth, mucosal detail is superior. The elasticity of the rubber and its tear strength, which is higher than silicone or polysulfide materials, allow the impression to be removed from the cast without fracture of the delicate ridge on the cast. Greater magnitude of this force is an evidence for higher interfacial surface tension and capillarity as well as more accurate fitting of the denture to the denture bearing area. This contributes to reduction of iatrogenic traumatic manifestations, increased retention and stability, higher mechanical strength of the maxillary complete acrylic denture and better patient’s comfort.15–18

V. CONCLUSION

Maxillary dentures processed by injection moulding technique showed higher mean values of denture retention as compared to dentures processed by compression molding technique. The dentures made by both the techniques showed acceptable retention on clinical examination.

REFERENCES


