COMPARATIVE EVALUATION OF CHANGES IN VERTICAL DIMENSION ON COMPLETE DENTURE FABRICATED USING COMPRESSION MOULDING AND INJECTION MOULDING TECHNIQUES

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ABSTRACT

Statement of problem: A clinically significant vertical dimension changes may occur after processing complete dentures with conventional method. One of the common reasons is polymerization shrinkage. Attempts to overcome this problem have resulted in the development of the continuous injection system where resin injected under continuous pressure to compensate the expected polymerization shrinkage.

Purpose of the study: This study was to compare and evaluate changes in vertical dimension on complete denture fabricated using compression moulding and injection moulding techniques.

Material and method: 40 maxillary complete dentures were fabricated. 20 maxillary polymethyl methacrylate dentures processed by conventional compression moulding technique and 20 maxillary dentures processed by injection moulding denture. Vertical dimensions of verified trial denture and processed denture were measured on the articulator with the help of digital vernier calliper and recorded separately. The recorded readings were evaluated and statistically analysed.

Result: A significant vertical dimension changes discovered within the group between trial and acrylized denture of both technique. While collated the compression molding and injection molding technique, there was a significant difference in vertical dimension changes (t test).

Conclusion: Both the compression and injection moulding technique showed the vertical dimension changes after denture processing. While comparing both the denture processing technique, injection moulding technique showed less vertical dimension changes than compression moulding technique.

Clinical implication: In this study denture processed by injection molding technique showed less vertical dimension changes there by helps in limiting extensive occlusal correction during laboratory remounting and maintains the quality of the denture teeth.

Key words: vertical dimension, complete denture, compression moulding, injection moulding.

I. INTRODUCTION

Senescence produces numerous changes in the stomatognathic system and in its components. (1) Numerous factors should be observed during prosthodontic rehabilitation of the senile patient. One of those factors is vertical dimension. Several teeth loss along with extreme bone loss affects the normal occlusal plane and reduces vertical dimension of occlusion. These conditions bring about changes in the temporomandibular joint, loss of normal face proportions, aesthetics, speech and function (2). A very important factor to restore aesthetics and function in the complete denture wearers is the assessment and reestablishment of the occlusal vertical dimension. Each and every clinical and laboratory procedures including the materials and methods should be focused to re-establish proper vertical dimension.
Poly methyl methacrylate is the material of choice for denture fabrication since 1930’s (3). Conventional compression moulding technique is the most accepted method (4) of denture processing. However, a laboratory remount with occlusal correction is necessary to maintain the developed trial denture occlusal contacts (5) with this method. The effort to eliminate polymerization shrinkage and laboratory remounting resulted in the development of the continuous injection system in 1940’s, in which resin will be injected under continuous pressure throughout the processing procedure to compensate polymerization shrinkage of the resin (6).

Several literatures support the fact that injection molding techniques might result in fewer dimensional inaccuracies and more accurate denture base than conventional processing techniques (7). Therefore, this study was conducted to compare and evaluate changes in vertical dimension on complete denture fabricated using compression molding and injection molding techniques.

II. MATERIAL AND METHOD:

A total of 40 maxillary complete acrylic dentures were made on 20 patients with maxillary and mandibular edentulism. Each patient received two maxillary dentures fabricated by both technologies. In this study maxillary denture fabricated by compression molding technique considered as Group 1 and injection molding technique as Group 2.

In this investigation primary impression was made with impression compound and poured in dental plaster (Kaldent, Kalabhaid). Special trays were made with self activated acrylic resin. Single step border moulding (Aquasil, Densply) and secondary impression in polyether impression (3M ESPE) was made for maxillary denture bearing area and zinc oxide eugenol (DPI Impression paste) secondary impression of mandibular ridge were made. Dental stone (Kalstone, Kalabhai) was used to pour the secondary impression after beading and boxing and master cast were obtained. Agar duplicating material was used to duplicate the master cast for two different processing techniques. After obtaining the two maxillary casts, occlusal wax record base were made and jaw relation was accomplished in patient’s mouth (fig 1A). Then articulation and teeth setting were carried out. During teeth setting - for the injection molding technique holes were made in the teeth for mechanical retention of acrylic teeth to flexible denture base. This technique of retention of acrylic teeth with flexible denture base is known as Retento-Grip tissue bearing technique.

Subsequently trial denture verification was finalized clinically (Fig 1B) and placed back onto the articulator. Now trial denture vertical dimension was measured with a vernier calliper using two standard points marked on the articulator and noted (Fig 2A). Denture fabrication was carried out using two different processing techniques and processed dentures were remounted on the articulator with the help of index markings placed over the cast before occlusal wax record base articulation. Acrylized denture vertical dimension was measured using same two standard points on the articulator with vernier calliper and noted (Fig 2B). Later, obtained measurements were statistically analysed.

![Fig 1 – A. Jaw relation and B. Trial denture verification](image-url)
III. RESULT:

This study on vertical dimension changes in complete denture processed by compression molding and injection molding technique revealed whatever be the technique there will be some changes in the vertical dimension after denture fabrication. In group 1, Compression molding technique the mean vertical dimension and standard deviation of trial and acrylized denture were 125.63±13.27 and 127.42±13.25 respectively (Fig 4A). In group 2, Injection molding technique the mean vertical dimension and standard deviation of trial and acrylized denture were 125.63±13.27, and 126.39±13.25(Fig 4B).

For Group 1 compression moulding technique the t test value between trial and acrylized denture was 10.7028 and p value < 0.05 and for Group 2 T value and p value of trial and acrylized denture of injection moulding technique were 21.6682, p value < 0.05. This clearly show the increase in denture vertical dimension after denture processing. (Table 1 and 2)

<table>
<thead>
<tr>
<th>Table 1 - Paired t – test of group 1 compression moulding technique trial and acrylized denture vertical dimension</th>
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<tbody>
<tr>
<td>Group 1 – Compression moulding</td>
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</table>
Table 2 - Paired t – test of group 2 injection moulding technique trial and acrylized denture vertical dimension

<table>
<thead>
<tr>
<th>Group 2 – injection moulding</th>
<th>N</th>
<th>Mean</th>
<th>t value</th>
<th>p value (1 tailed)</th>
<th>p value (2 tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial denture</td>
<td>20</td>
<td>125.6285</td>
<td>21.6682</td>
<td>0.000000000000000369347</td>
<td>0.00000000000000007387</td>
</tr>
<tr>
<td>acrylized denture</td>
<td>20</td>
<td>126.3890</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

While comparing group 1 and 2, the mean vertical dimension changes between trial and processed denture of group I compression moulding technique was 1.83 mm and group II was 0.7505 mm (Fig -6 ). The t-test value was 7.15 and p value < 0.005 (Table – 3). Hence it was proved that the vertical dimension difference of trial and processed denture between the two methods (conventional and injection moulding) was highly significant.

Table 3 - Paired t – test for mean vertical dimension difference of trial and acrylized denture between group 1 compression moulding and group 2 injection moulding technique

<table>
<thead>
<tr>
<th>Method of processing</th>
<th>Mean vertical dimension difference</th>
<th>Std Deviation</th>
<th>t value</th>
<th>p value (1 tailed)</th>
<th>p value (2 tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compression moulding</td>
<td>1.8345</td>
<td>0.64436</td>
<td>7.1465</td>
<td>0.0000000429019</td>
<td>0.000000858038</td>
</tr>
<tr>
<td>Injection moulding</td>
<td>0.7505</td>
<td>0.15360</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig 4 - A. The mean of trial and processed dentures vertical dimension processed by compression moulding. B. The mean of injection moulding technique trial and processed dentures vertical dimension
Fig 5- Comparison of mean difference in vertical dimension of trial and processed denture between conventional and injection moulding technique

IV. DISCUSSION:

Diminution of innate teeth and subsequent replacement with acquired prosthesis in the mouth is not a pleasurable event for any individual. At the same time distress of the patient can be minimized to extend by a prosthesis which reinstates the original facial appearance and functions similar to natural teeth. Determining a correct Occlusal Vertical Dimension is one of the important steps in accomplishing the above objective. Determining the lower facial height should not be neglected because if Occlusal Vertical Dimension is registered too high or too low, it would ruin the existing patient’s condition.

Both clinical and laboratory procedures should be done carefully to avoid the unnecessary vertical dimension changes. Especially for complete denture from the primary impression to finishing and polishing of denture, every step should be carried out with caution. Because the lab procedures including materials (properties) and method used are one of the common reason which results in change in established vertical dimension.

Several studies have been conducted regarding the vertical dimension changes in processed denture. Some of those including vertical dimension changes due to different flasking technique by Lais R Silva-Concílio et al., investment materials by Alaa’a M. Salloum, different rebasing technique by Shammas Mohammed et al etc. Despite the development of numerous denture base materials, acrylic resin remains the standard choice. However, polymerization shrinkage is seen while using acrylic resin and is one of the important factors in vertical dimension change. The conventional compression molding method (heat polymerization method) is the most applicable method for molding and curing acrylic resin due to its simplicity and relatively good accuracy. Therefore, this method has been considered as the gold standard to compare with other techniques. Injection molding technique is one of the denture processing techniques introduced to reduce polymerization shrinkage thereby minimize vertical dimension changes. So, this study was conducted to evaluate the changes in vertical dimension of complete dentures fabricated using heat activated acrylic resin using compression moulding and injection moulding techniques.

To avoid vertical dimension changes other than processing technique every material and procedure used in this current study was carefully manipulated. According to the study by Kakatkar, it was observed that 78% of dentist use impression compound to make preliminary impression. Merits of this material are economical, do not produce irritation to the patient and can be resoftened and remodified till the accurate impression is obtained. Single step border molding was carried out in the study because the sectional border moulding method has proved disadvantageous due to an increase in the number of insertions that makes the technique tedious, erroneous. Dentsply aquasil putty border molding and polyether final impression had been made in the present study. This method was suggested and also used by Smith et al.

Accurate cast duplication was essential to know the superiority of two denture processing technique. Agar was used to duplicate the master cast in the present study. This material is reversible hydrocolloid impression material and has adequate strength and elastic properties so that minor undercuts duplication is feasible and an accurate cast may be obtained.

Temporary denture base materials are shellac base plate, self activated acrylic resin, vacuum formed poly vinyl or polystyrene and base plate wax. In this study auto polymerizing / self activated resin was used as a temporary denture base material / record base material because it prevents dimensional change due to mould expansion at
higher temperatures (13). The base of the mounting cast is sharply grooved for cast remounting. This facilitates exact means of correcting occlusion changes result from the processing error.

For compression moulding technique in the present study, removal of excess resin after trial closure by placing cellophane sheet between the resin in the mould cavity and the cast had been carried out. Because it was reported that the most important factor in increasing the vertical dimension of occlusion was excess acrylic resin in the mould at the time of final closure. Nevertheless the exact method of packing and processing there will be 0.5 mm or less pin opening. It’s probably due to polymerization shrinkage.

In this point of view, Gary C. Anderson et al compared the dimensional changes of heat-cured poly (methy1 methacrylate) resin processed by the injection processing system with compression moulding processing system and concluded that the injection processed resin exhibited significantly less polymerization shrinkage than the compression processed resin.

Erika Garfunkel stated that dentures that have been processed by the pack and press method show greater changes in a horizontal and diagonal direction than dentures processed by the injection-pressing method (14). But the amount of pin opening with the injection method was nearly two times greater than with the compression method. These study helps to elucidate quarrel reports of changes in the vertical dimension of complete dentures processed by the compression and injection methods and gave an idea and interest to conduct the current study.

In the present study the mean increase in Occlusal Vertical Dimension, after processing by compression moulding was 1.83 mm. The result was somehow similar to Shammas Mohammed et al study showed that the incisal pin opening was found to be between 1.25 and 1.55 mm, where as greater than those found by Nogueira et al study (1.16 mm), Dukes et al (0.76 mm), Strohaver (0.63 mm),Wesley et al (0.56 mm), Chintalacheruvu et al (0.52 mm) (15), Nelson, Kotwal, Sevedge and Strohaver the rise of incisal pin produced by compression moulding procedures were under 1 mm. Differences in the methodology, such as anatomy of the casts, acrylic resin used, and number of trial packing(s), mayexplain the different results among these studies.

The mean vertical dimension change of dentures processed by injection moulding technique of this study was 0.75 mm. This was greater when compared with Robert AS study (0.001±0.003 inch) and Chintalacheruvu et al study (0.25 mm).

However, comparing denture from compression moulding and injection moulding technique, in the present study dentures fabricated by injection moulding technique showed less vertical dimension when compared to that of compression moulding technique. Kalina Georgieva et al, Kotwal et al, Kennan et al, Márcia Sampaio Campos, Sykora, Nogueira, Chintalacheruvu et al(15)and Trage also supporting the result of the current study.

A few studies were contradicting the result of the present study. Those are a study by Hardy on dentures processed with compression moulding technique reported an average pin opening of 2.3793 mm, which was well above the recommended range. The study of Garfunkel, although confirming the superiority of the injection moulding system regarding horizontal changes, concluded that the pack-and-press method is better when analysing the vertical changes. Vertical dimension change in injection moulding technique was almost twice when compared to compression moulding system and was not coinciding with the present study. These differences in pin rise reported from various studies may be because of variations in samples tested, materials used for processing, technical specifications, and methods used for measurements that were followed by different researchers.

So, all available data, from the present study and from most of the other studies, suggest that the use of the injection system under manufacturer’s instructions results in better dentures, decreasing the time spent in the occlusal adjustment. Statistically, significant difference was reported between compression and injection moulding techniques. Injection moulding technique was shown to exhibit more accuracy which could be because of various advantages offered by this system, which includes (1) continuous injection of material with a reservoir of resin which compensates for processing shrinkage, (2) absence of resin flash between the compartments, (3) absence of residual stresses with injection moulding systems, (4) well-controlled and proportioned polymer to monomer ratio.
V. CONCLUSION:

With in the limitation of this study it was concluded that

1. Both the compression and injection moulding technique showed the vertical dimension changes after denture processing.

2. While comparing both the denture processing technique, injection moulding technique showed less vertical dimension changes than compression moulding technique.

Limitation of this study:

There are limitations with both methods (compression and injection moulding techniques). Since the making of a denture is a complex process, which requires some standardization. Properties of the resin and differences in polymerization shrinkage also might have contributed to these variations. And as this study is an in vivo study that was conducted on completely edentulous patients, there were variations in the area of denture bearing surface and residual ridge forms. These factors may alter the amount of resin used for each denture, thereby affecting amount of polymerization shrinkage which may be one of the causes of inaccuracy. Secondly, the number of participants of this study was 20; if it could be conducted on large sample size, will give a result with more precision and power. Thirdly, in this study only one type of injection moulding resin was used. It was reported that variations within two injection moulding systems may also result in different vertical dimension changes because of difference in material (pre-polymerized and un-polymerized poly methyl methacrylate resin). From this study it was suggested that further studies on vertical dimension changes need to be carried out with different injection moulding systems.

REFERENCES: