Comparing the Accuracy of Marginal Fit of Cast Metal Crowns prepared by Two Different Casting Procedures: An invitro Study

C.Sabarigirinathan¹, K.Vinayagavel¹, Vijay Singh Chauhan¹, S.Narayanan¹, M.Saravanapriya¹, Arya Sukumaran², D.Deepiha³

1-Professor and HOD, Department of Prosthodontics, Tamil Nadu Government Dental College and Hospital Chennai. 2-Professor, Department of Prosthodontics, Tamil Nadu Government Dental College and Hospital Chennai. 3,5,6,7-P.G.Student, Department of Prosthodontics, Tamil Nadu Government Dental College and Hospital Chennai. 4-Phd student Department of Prosthodontics, Tamil Nadu Government Dental College and Hospital Chennai.

ABSTRACT

Casting procedure plays a major role in the field of Dentistry especially in the fabrication of various types of restoration such as inlays, onlays, crowns and fixed prosthesis¹. W.H. Taggart in 1907 advocated lost wax technique, and is widely used for all casting procedure and reshaping up of the metal into a desired shape can be achieved by means of casting.

KEYWORDS: Casting, Metal crowns, Investments, Chrome cobalt alloys

INTRODUCTION

In this study, two different types of casting technique are used. Conventional casting procedure usually takes a longer time to obtain an adequate expansion of mould space.² Although it gives good results and adequate fit of the restoration, the time consumption is a sensitive factor in the present day practice. On the other hand, the accelerated casting technique was introduced by Marzouk and Kerly in 1988. Although the accelerated casting technique reduces the time factor, the marginal fit of the cast restoration especially in long span replacement, was thrown out into a debate.³ Hence it was decided to compare the conventional casting procedure with accelerated casting procedure by using the laboratory samples as in vitro study.

MATERIALS AND METHODS

Steel casting ring size no.1, cellulose ring liner, sprue wax, phosphate bonded investment material, metal die, furnace, centrifugal casting machine, and traveling microscope.

Methodology: The prepared patterns are basically divided into Group I and Group II representing two different types of casting procedures.

- Group I - conventional casting technique
- Group II – Accelerated casting technique

Preparation of steel die (Fig.-1)

Base: A machined steel die is used to fabricate, gypsum models for the fabrication of wax pattern. The steel die simulated a prepared crown having the height of 6 mm and 6 mm diameter cervically with 10° axial wall taper.

A steel ring is a prepared height of 1 mm and width of 1mm to simulate the shoulder.

Body: Body is completely encircling the crown portion of the base with an opening in center 1mm larger in all dimensions than the crown in the base which provides uniform thickness for resin pattern. The body of the die has an opening on either side which helps to orient with the base of the die.

Lid: It measures by 62x62 mm. It has a space at the middle which helps to orient with the body of die to provide 1 mm thickness to resin pattern at the occlusal aspect.

Preparation Of Stone Die: Addition silicone of putty consistency is used to prepare the stone dies by making impressions from the steel die. Type IV dental stone is mixed with distilled water poured into the putty impression and stone dies are obtained and a total no. of 40 stones dies is prepared for this study.

Fabrication Of Resin Pattern: After preparing the stone dies in type IV dental stone. The body of the metal die is...
lubricated with petroleum jelly and assembled over the stone die the pattern resin available in powder, and liquid form is mixed in a glass beaker and poured in the space around the crown in the stone die base to create a pattern with the uniform wall thickness of 1mm. The resin is poured until it overflows over the body of the die then the lid is placed over the die and bench cooled. The resin patterns are retrieved from the die after 30 minutes, and the margins are examined, the excess material was cut with the sharp instrument. A reference mark has scribed on the margin of each pattern and the margin of its respective die. The distance between the margin of the pattern and the margin of the stone die was measured using traveling microscope (x 50 magnification) with μm accuracy.

**Investing Resin Pattern:** Each pattern was invested after marginal refinement metal casting rings were used and lined with one non-overlapping layer of cellulose ring liner to get an adequate expansion of investment to compensate for the casting shrinkage of metal copings.

**Resin Pattern Elimination:**

*For conventional technique:* Resin pattern elimination was done with an electrical furnace. After investing the pattern, bench cooling time of 60 minutes was allowed before placing the casting ring into the furnace at room temperature, and the temperature is increased gradually, and the holding temperature are followed as mentioned below.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Temperature Increase</th>
<th>Holding Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>23 – 270°C</td>
<td>7 - 10 C / minute</td>
<td>30 minutes</td>
</tr>
<tr>
<td>270 – 560°C</td>
<td>7 - 10 C / minute</td>
<td>20 minutes</td>
</tr>
<tr>
<td>560 – 750°C</td>
<td>7 - 10 C / minute</td>
<td>30 minutes</td>
</tr>
</tbody>
</table>

Table 1: Procedure involved in Conventional Technique

*For Accelerated Technique:* For accelerated technique after investing the pattern, bench cooling time of 14 minutes was allowed before the ring was placed inside the furnace which is already preheated to 850° C. The ring was left in the furnace for 30 minutes to enable the complete burn out of the wax and to achieve thermal expansion.

**Casting Procedure:** Casting for Group-I and Group-II after burnout procedure, were done in centrifugal casting machine. Nickel-Chromium, Pellets was used for the casting procedure, and all casting was cooled to room temperature.

Each casting was seated on its respective stone die and checked for proper fit (Fig-2). Travelling microscope was used with 50x magnification to measure the gap between the margins of casting and top of the stone die platform.

(Fig-3). Microscopic preparation measurements were made at four predetermined points, and the marginal gaps were measured to the nearest micron on each casting.

**RESULTS**

Accurate marginal fit of the restoration is quite important for the success of fixed Prosthesis. The influence of two different types of casting technique, conventional and accelerated technique with Ni-Cr alloy samples were evaluated in this study. The marginal fit was measured with Traveling microscope with 50x magnification, and the results are tabulated.

Table 1 and 2 shows the marginal fit discrepancy of cast crown in relation to two different types of casting techniques. The marginal gap values are resulted in cm. The results are analysed using two statistical analysis tests:

1. One-way ANOVA test – to compare between groups
2. Student - T test – to assess the significant difference within groups.

The basic data results of marginal gap discrepancy values of cast crown made by two casting technique are tabulated.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Group I</th>
<th>Group II</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CONVENTIONAL CASTING</td>
<td>E-accelerated casting technique</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Marginal Gap (cm)</td>
<td>Marginal Gap (cm)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.031</td>
<td>0.011</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.021</td>
<td>0.021</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.031</td>
<td>0.027</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.011</td>
<td>0.021</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0.031</td>
<td>0.022</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>0.041</td>
<td>0.012</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>0.021</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>0.031</td>
<td>0.034</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>0.041</td>
<td>0.013</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>0.031</td>
<td>0.023</td>
<td></td>
</tr>
</tbody>
</table>

Table 1 – shows the marginal gap of conventional casting and B - accelerated casting technique

<table>
<thead>
<tr>
<th>Sub Group</th>
<th>Marginal Gap in cm</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Group I</td>
<td>0.027</td>
<td>0.009</td>
</tr>
<tr>
<td>Group II</td>
<td>0.019</td>
<td>0.007</td>
</tr>
</tbody>
</table>

Table 2 – shows the means and standard deviations of Group I and II samples. Note: * Denotes significance at 5% level
Table 1 shows the of marginal gap mean value of Group I samples. Group I A conventional technique with Moldavest has a mean value of 0.027 and Group I B accelerated technique with Moldavest has a mean value of 0.019. So there is a difference between the two subgroups of about 0.010. This shows the significant difference between the two types of investment material by conventional casting technique. This study implies that there are two casting methods namely conventional and accelerated technique using two commercially available. Phosphate bonded investment material has no statistically substantial difference.

**DISCUSSION**

Marginal integrity of cast metal restoration is one of the key factors to the success of a fixed prosthesis. The accuracy of fit is affected by the various factors such as tooth preparation, the accurate impression, the working cast, the quality of wax and its distortion and solidification shrinkage of the molten metal.

Conventional casting technique is the one, which ensures more accurate cast fit and it was believed that the conventional casting technique is more reliable than other techniques described in the literatures. Accelerated casting technique (marzouk and kerly 1988) is another accepted method of casting procedure, which has been practiced in the past few years. Konstantoulakis Schilling have measured the vertical distance between the margins of the casting and the finish line, hence in this study the marginal discrepancy of the casting produced by the conventional and accelerated technique was measured in the vertical direction by using traveling microscope.

The mean marginal gap of the Group I A samples is 0.027 cm, Group I B samples is 0.021 cm, whereas the marginal gap of Group II A sample is 0.019 cm, Group II B sample is 0.018 cm which are statistically momentous at 5% level. The various authors who had done this type of study have stated as follows, Christensen 74 μm, Dedmon 104 μm, Mclean 120 μm. However this marginal gap is considered to be clinically acceptable.

**CONCLUSION**

In this study, two different types of commercially available phosphate bonded investment were selected and cast metal coping was prepared on the type IV gypsum die. Alloy samples were prepared by using accelerated and conventional casting procedure. The metal copings were tried on respective stone dies to check the marginal fit by using travelling microscope.

Within the limitations of the present study, the following conclusion can be arrived:

1. Marginal gap for casting was made with accelerated technique showed null statistical difference when compared with a conventional casting group.
2. There is no statistical difference between group I and group II for both the techniques of casting.
3. The accelerated casting technique offers a cost effective and time saving casting method.

Further elaborate study has to be conducted before confirming the efficacy of accelerated casting technique and to consider this is effective and time saving. When compared with conventional casting procedure which has been in practice in many dental casting laboratories.

**REFERENCES**

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Conflict of Interest: Nil