EVALUATION OF MARGINAL FIT OF METAL CROWNS CASTED USING CONVENTIONAL CASTING TECHNIQUE AND ACCELERATED CASTING TECHNIQUE – A COMPARATIVE INVITRO STUDY

Anusha Yarram¹, Rama Raju A.V², Suresh Sajjan M.C³, Narasimha Rao Guddala⁴, V S Lakshmi Thorreti⁵, P.V. Rajesh Kumar⁶.

¹Reader, Dept of Prosthodontics, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India
²Professor, Dept of Prosthodontics, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India
³Professor, Dept of Prosthodontics, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India
⁴Assistant Professor, Dept of Prosthodontics, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India
⁵Assistant Professor, Dept of Prosthodontics, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India
⁶Reader, Dept of Prosthodontics, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India

Corresponding Author: Anusha Yarram, Reader, Dept of Prosthodontics, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India

Background: The conventional investing and casting technique is time consuming, requires 3-4 hours for completion. The accelerated casting technique has evolved with an emphasis to shorten the processing time without compromising the quality of castings. Commercial rapid heating phosphate bonded investments have evolved to reduce the operating time during the dental casting process.

Aim of the study: To evaluate the effect of rapid heating protocols on the marginal accuracy of base metal cast crowns fabricated using two different phosphate bonded investment materials.

Materials and Methods: A master die was fabricated representing prepared tooth and 60 duplicate stone dies were fabricated from the master die. 60 standardized wax patterns were fabricated on the stone dies. The prepared patterns were divided into A, B groups depending on the type of investment material used, and were further subdivided into A₁, A₂ and B₁, B₂ based on type of burnout and casting schedule used. Wax patterns in Group A (n=30) were invested using Bellasun investment (Bego, Herbst GmbH, Germany), and wax patterns in Group B (n=30) were invested using Formula-1 investment (Whipmix Corp. Louisville., USA). Samples in Groups A₁, B₁ were casted using conventional burnout and casting schedules after one hour bench set time, whereas samples in Groups A₂, B₂ were casted using accelerated burnout and casting schedules after 30 minutes bench set time. Ni-Cr alloy was used as the casting material. The master die-casting assembly was kept under stereomicroscope and marginal gap was estimated from casting margin to finish line on master die at five predetermined reference points at X40 magnification (in µm). The obtained values were statistically analyzed using One-way ANOVA test and Student t-test.
Results: The mean marginal discrepancy values of Groups – A1, A2, B1, and B2 were 44.36 µm, 72.8 µm, 23.33 µm, and 40.16 µm respectively. The mean marginal discrepancy values of cast copings obtained by accelerated casting technique were significantly higher (p = < 0.001) than those obtained by conventional casting technique. The mean marginal discrepancy values of cast copings obtained by using Formula 1 were significantly lower (p = < 0.001) than those obtained by using Bellasun.

Conclusion: The accelerated casting technique can be employed to obtain castings in significantly less time (1 hour : 3 hours, 26 minutes) without compromising the quality. The cast copings obtained by accelerated casting technique using Formula-1 investment have shown better marginal accuracy than those obtained by using Bellasun investment. However, both the investment materials tested, Bellasun and Formula 1 have shown marginal gap within clinically acceptable limits (30-120 µm), in both conventional casting technique and accelerated casting technique.

Key words: Conventional casting technique, Accelerated casting technique, Marginal gap, Rapid heating phosphate bonded investment.

INTRODUCTION
Casting of metals by lost-wax process has been used since ancient times, it has became common practice in dentistry after it was introduced by William H. Taggart in 1907. Castings made by Taggart were generally too small and did not fit the cavities properly. The accuracy of fit is affected by the quality of tooth preparation, the impression, the working cast, the quality of wax that is used, the wax pattern, time lapse between wax pattern fabrication and investing, type of alloy that is used, coefficient of thermal expansion of the alloy, properties of the investment material, and the accuracy of the casting procedures. The accuracy of casting is subjected to the volumetric changes occurring due to shrinkage the solidified alloys. The method of achieving compensation for shrinkage of the solidifying alloys by setting, hygroscopic and thermal expansion of the investment has been scientifically studied.

The casting process used in dentistry based on lost wax technique has been receiving continuous investigations by improving investment materials and techniques. The majority of the efforts deal with ‘conventional’ investing and casting technique, which usually require at least 1 hour bench set for the investment, followed by one, two or three stage wax burnout cycle as recommended by the manufacturer before the casting procedure. The whole process is time consuming and requires approximately 2 to 4 hours for completion. The accelerated casting technique has evolved with an emphasis to shorten the processing time without compromising the quality of castings. The investment mold is directly placed at higher temperature in a preheated furnace after a bench set time of 30 minutes. Hence, the whole procedure from investing to casting can be performed within 1 hour. Marginal discrepancies and surface roughness by accelerated casting technique were shown to be within the clinically acceptable limits. However this procedure was found to be technique sensitive. Previous studies on accelerated casting technique have verified the casting accuracy with an emphasis on noble metal alloys. Ni – Cr alloy is one of the base metal alloys that is being popularly used for the fabrication of metal or ceramo - metal restorations. Accelerated casting technique using rapid burnout phosphate bonded
investment in case of base metal alloys was not extensively studied. It was argued that the dimensional accuracy of the casting might be affected by change in the properties of the investment subjected to different heating methods. Rapid burnout investments have evolved in response to the laboratory’s need to reduce the processing time. Formula 1 (Whipmix Corp. Louisville, USA) is a high performance phosphate bonded investment designed for both standard and rapid burnout schedules. Hence, the study was formulated to verify the feasibility of using Formula 1 investment for accelerated casting technique with regard to base metal alloys. Hence, the present study was designed and conducted to investigate the differences in the marginal discrepancies of Ni - Cr alloy cast copings employing (A) Two different casting techniques: Conventional casting technique and accelerated casting technique; (B) Two different phosphate bonded investment materials: Bellasun (Bego, Herbst GmbH, Germany) and Formula 1 (Whipmix Corp. Louisville, Ky., USA).

MATERIALS AND METHODS:

Fabrication and duplication of master die: The stainless steel master die was fabricated from a stainless steel cylinder having dimensions of 8mm length and 10mm diameter. The master die was milled with 2 mm of occlusal reduction and 1mm of axial reduction at the finish line with a total taper of 6 degrees cervico-occlusally (Figure 1). An axial groove on the master die was prepared with 171L tungsten carbide bur using straight air turbine laboratory hand piece secured to the surveyor, so as to align the groove parallel to the long axis of the master die. The prepared master die was duplicated in type IV dental stone (Pearl stone, Asian Chemicals) by making impression of master die using Polyvinyl siloxane impression material, Monophase (Aquasil, Dentsply, Germany) loaded in custom tray and simultaneously injecting over the master die. Die spacer (Color Spacer, Han Dae Chemical Co. Ltd) was applied on all the axial walls except the axial groove, 0.5mm away from the finish line and on the occlusal surface. 60 stone dies were obtained and randomly assigned into 2 groups: A and B. Further samples in A and B groups were subdivided into A1, A2 and B1, B2.

Wax pattern fabrication:
A stainless steel former (Figure-1) corresponding to the prepared surface of master die was fabricated to standardize the fabrication of all 60 wax patterns. The ring was fabricated with an inner diameter of 10 mm, outer diameter of 11 mm and height of 8mm. Standardized wax patterns of 1mm thickness were made on the lubricated stone dies using inlay wax (Hindustan dental product, Hyderabad) (Figure-2). Preformed wax sprue (Bego, Breman, Germany) of 3mm diameter and 2.5 cm length was attached at 45-degree angle to the occlusal surface of each wax pattern.

Investing procedure:
To minimize distortion, all the wax patterns were invested immediately. Wax patterns were attached to the crucible former with sprue wax and debubblizer (Aurofilm, Bego, Germany) was sprayed to reduce the surface tension of all wax surfaces. A 6 mm distance was provided between the wax pattern and the top of the casting ring. Investing was done in 3X casting ring lined by ring liner and using phosphate bonded investment materials.
Group A (n=30): Invested using conventional phosphate bonded investment Bellasun (Bego, Herbst GmbH, Germany) (Figure-2) with liquid to powder ratio of 36 ml liquid / 150 grams of powder.

Group B (n=30): Invested using rapid heating phosphate bonded investment Formula-1 (Whipmix Corp., Louisville, Ky., USA) (Figure-1) with liquid to powder ratio of 33 ml liquid / 150 grams of powder.

The liquid was prepared by mixing colloidal silica and distilled water in a ratio of 80:20 to achieve optimum thermal expansion as recommended by the manufacturer. Mechanical mixing was done under vacuum using vacuum mixer (Sirio speedy mix, Italy) (Figure-17), and the casting rings were filled with investment. The investment molds were kept for 1 hour bench setting time in Groups A₁ & B₁, whereas in Groups A₂ & B₂ the investment molds were kept for 30 min bench setting time to allow for setting expansion.

Wax burnout:

Conventional wax burnout technique: After one hour bench-set time, the set investment mold was placed in the burnout furnace and the temperature was raised from room temperature to 430º C at the rate of 8º C per minute, with holding time for 30 minutes. A rate of 14º C per minute was used for second cycle upto 930º C, with holding time for 30 minutes. The total time taken for conventional protocol was approximately 3 hours, 25 minutes.

Accelerated wax burnout technique: The burnout furnace was kept ready which was preheated to 930º. After 30 minutes bench-set time, the set investment mold was placed directly in 930º C preheated burnout furnace for 30 minutes. The total time taken for accelerated protocol was 1 hour. The wax burnout procedure was performed in a burnout furnace (Unident Muffl, India) and the procedure was different for the test groups, Conventional wax burnout technique was followed for the samples in Groups A₁ & B₁, whereas Accelerated wax burnout technique was followed for the samples in Groups A₂ & B₂.

Casting procedure:

After the burnout process, the casting ring was transferred immediately to induction casting machine (Fornax GEU, Bego, Germany) to prevent heat loss from the casting ring. Ni- Cr alloy was heated sufficiently till the alloy ingot turned to a molten state, and the crucible was released and centrifugal force ensured the completion of casting procedure. After the casting ring had cooled down to room temperature, the castings were retrieved from the casting ring and the investment was removed. Sandblasting was done thoroughly with 150 µm alumina to remove the remaining investment (Easyblast, Bego, Germany). Sprues were cut from the casted metal crowns. Individual castings were then examined under magnification for any bubbles and irregularities & were carefully removed with tungsten carbide bur at slow speed. Castings with defects and bubbles present on inner surface were discarded. The fit of the castings were verified on corresponding test dies for marginal adaptation & seating of the crowns (Figure-3).

After the fit of the crowns were considered acceptable, the external surface of castings was finished with the help of tungsten-carbide burs, stones, rubber discs, brush wheels and finally light buffing with rouge.

Measurement of marginal discrepancy:

A metallic custom made device was fabricated for holding the master die and casting assembly to standardize the measurements (Figure-4). The base of the custom made metallic device was machined in the form of pentagon. Five reference lines corresponding to five sides of base were scribed on the master die - casting assembly,
each served as standard reference site for measurements. The master die – casting assembly was kept in the custom made device under standardized pressure. The samples were placed under stereomicroscope (SZX16 Olympus, Japan) (Figure- 5&6) and pictures were captured perpendicular to axial wall using Olympus DP 17 camera, at X40 magnification. The images of stereomicroscope were analyzed using Image-pro plus version-6.2 software, for measuring the vertical marginal discrepancy. The measurement of marginal gap was made to the nearest micron on each casting from casting margin to master die margin at five predetermined sites and at each site two measurements were recorded (Figure:7 ). The same procedure was followed to record the vertical marginal discrepancy for each of the 15 test samples belonging to the four test groups.

RESULTS
The data obtained from measurements was tabulated and statistically analyzed using ANOVA ( Analysis of variance ) and Student t-test. The mean marginal discrepancy values of Groups – A₁, A₂, B₁, and B₂ were 44.36 µm, 72.8 µm, 23.33 µm, and 40.16 µm respectively (Table-I). The mean marginal discrepancy values of cast copings obtained by accelerated casting technique were significantly higher (p = < 0.001) than those obtained by conventional casting technique. The mean marginal discrepancy values of cast copings obtained in the accelerated casting technique by using Formula 1 were significantly lower (p = < 0.001) than those obtained by using Bellasun.(Table-II).

TABLE I:
MEAN COMPARISON AMONG 4 GROUPS USING ANOVA TEST

<table>
<thead>
<tr>
<th>NO OF GROUPS</th>
<th>MEAN</th>
<th>SD</th>
<th>F VALUE</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A₁</td>
<td>44.36</td>
<td>13.38</td>
<td>173.187</td>
<td>&lt;0.001 S</td>
</tr>
<tr>
<td>A₂</td>
<td>72.8</td>
<td>17.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B₁</td>
<td>23.33</td>
<td>8.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B₂</td>
<td>40.16</td>
<td>13.17</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Statistically significant if P<0.05
NS: NOT SIGNIFICANT; S: SIGNIFICANT; HS: HIGHLY SIGNIFICANT

TABLE- II:
MEAN COMPARISON BETWEEN GROUPS USING STUDENT T-TEST

<table>
<thead>
<tr>
<th>NO OF GROUPS</th>
<th>MEAN</th>
<th>SD</th>
<th>t value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A₁</td>
<td>44.36</td>
<td>13.38</td>
<td>-11.257</td>
<td>&lt;0.001 S</td>
</tr>
<tr>
<td>A₂</td>
<td>72.8</td>
<td>17.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A₁</td>
<td>44.36</td>
<td>13.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B₁</td>
<td>23.33</td>
<td>8.88</td>
<td>11.343</td>
<td>&lt;0.001 S</td>
</tr>
<tr>
<td>A₁</td>
<td>44.36</td>
<td>13.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B₂</td>
<td>40.16</td>
<td>13.17</td>
<td>1.935</td>
<td>0.055 NS</td>
</tr>
</tbody>
</table>
DISCUSSION

The accuracy of fit of the casting is essential for longevity and clinical success of the cast restoration in the oral cavity. Lack of adequate fit is potentially detrimental to both the tooth and the periodontal tissues. Clinically, deficient margins can act as nidus for plaque retention resulting in secondary dental caries, adverse pulpal reactions, gingival inflammation, and periodontal diseases. Precise marginal sealing is important in dental restorations to fulfill biological, physical, mechanical and cosmetic requirements and to prevent failure of restorations. Published data on clinically acceptable marginal gap ranges from 30 µm to 120 µm. Marginal discrepancies are inevitable, despite careful attention to waxing, investing and casting. The rate of cement dissolution has been related empirically to the degree of marginal opening, thus larger the marginal gap and subsequent exposure of the dental luting cement to oral fluids, the more rapid is the rate of cement dissolution. Hence, for the success of cast restoration, marginal gap must be as minimal as possible. The first published attempt to accelerate the lost wax technique with the use of phosphate bonded investment for complete crown was made in 1988 by Marzouk and Kerby who recognized the importance of investment temperature. Their study revealed no statistical significant difference in circumferential marginal discrepancy between investment groups introduced in a 1350°C preheated furnace after 15 minute bench set and the conventional technique. The accelerated technique uses short bench-set intervals and rapid burnout cycles. The bench set time of one hour in conventional casting technique is reduced to about 30 minutes in the accelerated technique. In conventional heating cycle, the mold is placed in the burnout furnace at room temperature and slowly raised to maximum temperature (850-950 °C), and allowed to heat soak for 30 minutes. In accelerated casting technique, the conventional heating cycle is modified, where the mold is directly placed into the preheated furnace at maximum temperature (850 - 950 °C), and allowed to heat soak for approximately 30 minutes (Graph 1).
Graph 1: Time from investing to casting with Rapid Burnout compared to Standard Burnout.

The special liquid to distilled water ratio of 80:20 has been shown to offer adequate expansion for complete crown castings, as recommended by the manufacturers and hence was employed in the present study. The liquid to powder ratio was as recommended by the manufacturer i.e. 36 ml liquid / 150 grams powder for Bellasun investment; and 33 ml liquid / 150 grams powder for Formula 1 investment. The lower the water/powder ratio, the greater the effective setting expansion. At lower water/powder ratios, presence of more nuclei of crystallization per unit volume exerts more outward thrust of growing crystals. It was observed that for Formula 1 investment, the amount of liquid used was less to bring the powder particles together; so faster and greater expansion might be accomplished. Vacuum mixing and investing of all samples was done as recommended by the manufacturer. The casting procedure was performed by using an induction casting machine. A metallic custom made device was fabricated for holding the master die and casting assembly to standardize the measurements (Figure ). Five pre-determined points corresponding to the five sides of base were served as standard reference points for measurement of the vertical marginal discrepancy of all cast copings. The master die-casting assembly was kept under stereomicroscope and marginal gap was estimated from casting margin to master die margin at X40 magnification ( in m ). The mean marginal discrepancy values for Bellasun investment employing conventional and accelerated casting techniques were 44.36 µm and 72.8 µm respectively (Graph 2). The mean marginal discrepancy values for Formula 1 investment employing conventional and accelerated casting techniques were 23.33 µm and 40.16 µm respectively (Graph 2).
The marginal discrepancy of crowns made of base metal alloys was found to be in accordance with the previous studies, in both conventional and accelerated casting techniques. The reason for high marginal discrepancy of base metal alloys may be due to higher fusion temperature. The magnitude of the dimensional change is directly correlated with the thermal contraction associated with the cooling of the molten alloys. The shrinkage of alloys can occur because of, the differences in alloy compositions and plastic deformation that occurs with solidification and cooling of an alloy. The present study indicates no variation in marginal discrepancy all over the periphery, whether casting was obtained by short or standard protocol, indicating there may not be uneven thermal, as well as setting expansion of investment materials. In the present study, statistically significant difference (p < 0.001) was observed in the mean marginal discrepancy of castings fabricated using conventional casting technique and accelerated casting technique. Previous studies reported that the marginal gaps were five times higher with shorter burnout schedules than with longer burnout schedules using phosphate bonded investment material. The analysis of the results of the present study showed that the castings produced with accelerated casting technique showed higher marginal gaps in accordance with previous studies and the marginal discrepancy was approximately two times higher with accelerated casting technique compared to conventional casting technique. The short bench set time and rapid heating induces extreme stress on the mold. As a result, the binder chemistry and refractory chemistry have become more important. The refractory components, quartz and cristobalite were added to regulate the thermal expansion. On heating, quartz and cristobalite inverts from \( \alpha \) – form to the stable \( \beta \) – form. The volume increases and density decreases as \( \alpha \)- form changes to \( \beta \)- form. Quartz expands at a temperature of 575º C and cristobalite expands between 200 – 270 º C. Although cristobalite gives earlier and greater expansion than quartz, the volume ratio of cristobalite to quartz in phosphate bonded investments is estimated to be between 0.3 - 0.5. The higher content of quartz versus cristobalite usually makes the investment more resistant to fracture when heated rapidly. The thermal expansion of the phosphate bonded investment materials is the most important expansion for counterbalancing shrinkage of casted alloy from solidus temperature to room temperature.
produced. In phosphate bonded investments, higher heating rates have shown to decrease the thermal expansion of the investment.\textsuperscript{27} This could be explained by the fact that with sudden rise in temperature, fewer refractory grains are converted from $\alpha$ - form to the $\beta$ – form, thus smaller thermal expansion occurs. The accelerated schedules may take advantage of characteristic exothermal setting reaction of phosphate bonded investment. Heat enhanced setting expansion continues uninterrupted as the mold is transferred into a preheated furnace environment for thermal expansion.\textsuperscript{10} This may probably be the reason for the marginal discrepancy of cast copings by accelerated technique to be within the clinically accepted limit. Other probable reason may be the addition of metal powder to refractory powder. The metal powder increases the thermal conductivity of the refractory material, thereby improving heat transfer within the mold. With better heat transfer, there is no longer a large temperature gradient through the mold. As a result, the stresses that were caused by uneven heating of the mold are reduced, thus lowering the risk of explosive cracking.\textsuperscript{10} The importance of introducing the mold into the preheated oven when the investment has reached its peak temperature has been emphasized.\textsuperscript{10} While the investment reaches its maximum exothermic reaction temperature, most of the chemical reaction and the setting expansion is considered to have been completed and the investment has sufficient strength to withstand the thermal shock.\textsuperscript{10} When the investment is heated rapidly, water trapped in the pores of the investment vaporizes.\textsuperscript{2, 5} A characteristic surface roughness may occur because of the flaking of the investment material when the steam tries to escape through the porous mold. Further, steam may carry some of the salts used as a modifier into the mold, which are left as deposits in the walls of the mold cavity.\textsuperscript{2} Incomplete elimination of wax residues may occur if the heating is too short which can further affect the surface of the casting. Uneven expansion of the mold because of rapid heating can lead to marginal discrepancy of the casting \textsuperscript{2,5}. The mean marginal discrepancy values of castings produced with accelerated casting technique were within clinically acceptable range. This implies that the accelerated casting technique tested for Bellasun and Formula 1 investment materials can be expected to produce better quality castings with a clinically acceptable level of marginal discrepancy. However, with accelerated casting technique Formula 1 performed better than Bellasun, as Formula 1 is the dedicated investment especially for rapid burnout protocols. Opinions on the clinical relevance of the size of marginal discrepancies are controversial.\textsuperscript{44} Most authors agree that marginal discrepancies in the range of 30 to 120 μm seem to be clinically acceptable with regard to longevity of the restorations.\textsuperscript{3, 6} In the present study mean marginal discrepancy values between 23.33 and 72.8μm) were within biologically acceptable standards. Minimizing the marginal gap is necessary because an increase in the marginal gap results in an increase in cement dissolution, thus increasing the potential for microleakage.\textsuperscript{6} Open marginal configurations encourage microleakage of bacteria, their by-products, oral fluids and molecules or ions during dissolution of the luting cement. Bacterial products can easily diffuse through the dentinal tubules toward the pulp, evoking a pulpal inflammatory response.\textsuperscript{46} The exposed prepared tooth structure between the restoration margin and prepared tooth margin is commonly a rough surface, especially if prepared with diamonds. Rough surfaces are difficult to clean, if they are located subgingivally and the periodontium tends to remain chronically inflammed and is susceptible to long-term periodontal breakdown.\textsuperscript{28} Author conducted a study to evaluate the bacterial flora associated with onlays having “open” margins ( marginal gaps > 200 μm ) and clinically “ideal” margins, and concluded that the castings with open margins precipitated the
immediate colonization of the subgingival area with microflora resembling chronic periodontal disease. The “ideal” castings harbored only bacteria that are found in healthy gingival crevices. Previous studies have demonstrated the presence of bacteria in gaps between restoration and tooth structure. It is well established that secondary caries lesions involve two parts; an outer lesion and a wall lesion. The outer lesion occurs due to the presence of plaque at the restoration margin. The development of the wall lesion is dependent on the size of the gap at the tooth-restoration interface. The size of gap interfaces could have an effect on the metabolism of the bacteria inhabiting it. With small gap sizes, the diffusion of carbohydrates to the deeper areas of the tooth/restoration interface maybe hindered. This can reduce the bacterial activity and results in smaller wall lesions. Conversely, the presence of larger gaps may facilitate the diffusion of nutrients to the deeper areas, making the bacterial biofilm more active, eventually leading to wall lesions of larger sizes. Past investigations make it apparent that, within the commercially available phosphate-bonded investments, dissimilar performance characters were expected. The performance of the accelerated casting technique in the fabrication of fixed partial denture frameworks requires further investigation.

CONCLUSION

Within the limitations of the study the following conclusions can be drawn: The accelerated casting technique can be employed to obtain castings in significantly less time (1 hour : 3 hours, 26 minutes) without compromising the quality. The two investment materials tested, Bellasun and Formula-1, can produce castings with better marginal accuracy in conventional casting technique. The rapid heating phosphate bonded investment (Formula-1), can produce accurate castings with better marginal accuracy when compared to that of the conventional phosphate bonded investment (Bellasun), in accelerated casting technique. The mean vertical marginal discrepancy values of all the cast copings obtained were within the clinically acceptable limit.

REFERENCES:


Fig-1: Custom made stainless steel master die with former
Fig-2: Wax pattern on stone die  
Fig-3: Casting on master die

Fig-4: Custom made pentagon base stainless steel mounting device

Fig-5: Measurement of marginal discrepancy using Stereomicroscope
Fig-6: Custom made mounting device with master die-casting assembly under Stereomicroscope

Fig-7: Stereomicroscopic image showing measurement of marginal gap under X40 magnification