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Research Paper

COMPARATIVE EVALUATION OF MARGINAL DISCREPANCY OF CASTINGS MADE WITH CONVENTIONAL AND ACCELERATED CASTING TECHNIQUE USING TWO TYPES OF PATTERN MATERIALS"

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ABSTRACT:*OBJECTIVE: to measure the marginal discrepancy of Co- Cr copings made by two different pattern materials and two diiferent casting techniques*
METHODS: A total of 40 Cobalt - Chromium copings were fabricated on a standardized die using two types of pattern materials & two different casting techniques and divided into 4 groups with 10 copings each.
Group I : Conventional casting with inlay wax
Group II: Accelerated casting with inlay wax
Group III: Conventional casting with autopolymerizing pattern resin
Group IV: Accelerated casting with autopolymerizing pattern resin
Marginal gap of copings were examined under 40X stereomicroscope at two reference points. The measurements were put to statistical analysis.
***RESULTS :** Results showed minimal marginal discrepancy in copings fabricated using inlay pattern wax with conventional casting. Maximum marginal discrepancy was observed in casting fabricated using autopolymerizing pattern resin with accelerated casting.*
***CONCLUSION:** Within limitations of this study , all castings are in clinically acceptable range. Vertical marginal discrepancy is least with conventional casting technique as compared to accelerated casting technique and inlay wax is a better material than autopolymerizing pattern resin for pattern fabrication.*
KEYWORDS: *accelerated casting , autopolymerizing pattern resin, casting, inlay wax , and marginal discrepancy.*

I. INTRODUCTION

The success of the fixed restoration depends upon many factors and one of the prominent is the close adaptation at the margin of cast restorations. The marginal fit of castings basically relies on perceptive tooth preparation, accurate impressions, precision castings with careful finishing and cementation procedures.(1)
The literature revealed that clinically acceptable marginal discrepancy for cast restorations ranges from 10 to 160 µm. Still, most of the authors have considered marginal discrepancies exceeding 100 µm as an unacceptable marginal opening.(1)
Fixed restorations include all metal crown , porcelain fused to metal and all ceramic crown. Metal framework is casted using lost wax technique given by Taggart. This process includes one or two stage wax elimination procedure before casting is done. This procedure is time-consuming and requires approximately 2–4 hours for completion. Efforts have been made constantly to reduce this time consuming process.(2)
To reduce the procedure duration , Marzouk and Kerby proposed an accelerated casting technique which was an attempt to achieve quality results in 30-40 minutes.(3)

This technique offers many advantages to the patient, dentist, and dental laboratory technician, and has received increased attention as a method of improving productivity. Some studies, have reported that this procedure is technique sensitive. However, the effect of accelerated procedures on the marginal discrepancy of base metal alloy restorations has not been adequately studied

Present in vitro study was conducted to compare the marginal fit of copings made with conventional and accelerated casting technique using two different types of pattern materials i.e. inlay wax and autopolymerizing pattern resin.

II. MATERIAL AND METHODS

A custom stainless steel master die was fabricated with a sleeve to standardize the dimension of wax pattern , based on the model employed by Konstantoulakis et al.

The master die simulated a crown preparation with 10 degree axial wall taper. The height of the die and its occluso-gingival diameter is 6mm and finish line was 90 degree shoulder and 1mm in width. A stainless steel sleeve was prepared with 1mm gap.(Figure 1) Two reference points were marked on die for measurements.

20 inlay wax patterns (Figure 2) and 20 auto-polymerized pattern resin patterns (Figure 3) were fabricated. 4mm sprues were attached to the pattern at an angle of 45 degree. The patterns were removed from die with a gentle pressure. Surfactant spray was applied to reduce surface tension to all patterns thereby improving wettabilty with the investment material. The patterns were invested in ringless casting system.

Figure 1 :Stainless Steel DieWith Metal Sleeve

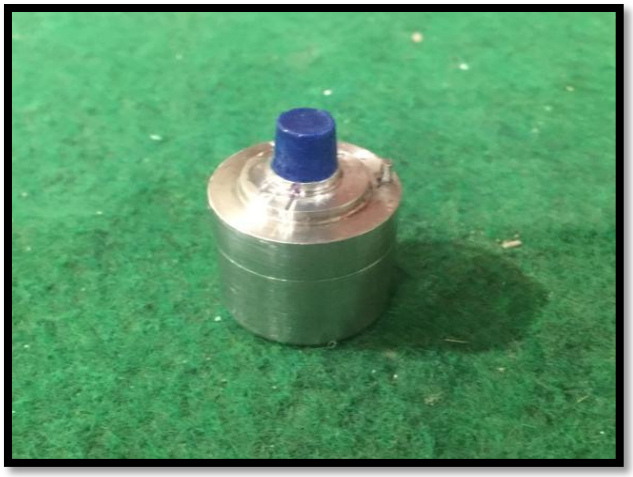

Figure 2 :Inlay Type B Pattern Fabricated On Die

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Figure 3 :Autopolymerizing Resin Pattern Fabricated On Die

The phosphate bonded investment material was vacuum mixed. The investment pattern was allowed to bench set for 30 minute. All the 40 patterns in four groups were invested in the same manner.
The inlay wax and auto-polymerized pattern resin patterns obtained were cast by conventional and accelerated casting techniques in four groups:

G-I: Conventional casting technique of Inlay Wax copings (10 samples): After a 30 minute bench set time,the wax burnout was done by using a programmed preheating schedule, i.e. the investment was kept in the furnace at room temperature and was heated continuously until 850℃ at the rate of 8℃ per minute.

G-II: Accelerated casting technique of Inlay Wax copings (10 samples): After a 30 minute bench set time, the set investment was placed directly in a preheated burnout furnace at 850℃, and held for 30 minute to ensure complete burnout of the wax pattern.

G-III: Conventional casting technique of Auto-polymerized Pattern Resin copings (10 samples): After a 30 minute bench set time , the pattern burnout was done by using a programmed preheating schedule, i.e. the investment was kept in the furnace at room temperature and was heated continuously until 850℃ at the rate of 8℃ per minute.

G-IV: Accelerated casting technique of Auto-polymerized Pattern Resin copings (10 samples): After a 30 minute bench set time, the set investment was placed directly in a preheated burnout furnace at 850℃, and held for 30 minute to ensure complete burnout of the Pattern Resin.

The preheated casting crucible and the investment mold were taken out of the furnace and were placed in the casting machine. Cobalt -Chromium alloy was heated sufficiently till the alloy ingot turned to molten state and the lever was released and centrifugal force ensures the completion of the casting procedure.
Investment was allowed to cool down to room temperature and the casting was divested.
Adherent investment was removed from the casting initially with hand instrument and then by sandblasting. The sprue was cut and removed at the junction of the coping with an ultra thin abrasive disc and the copings were subjected to ultrasonic cleaning & checked visually for any casting defects. Castings were finished with stone and rubber points. Internal positive defects were removed using a ½ round bur.
Each casting was seated on the stainless steel die with finger pressure until resistance was met. The marginal discrepancy of copings of all 4 groups were measured with the help of stereomicroscope under 40 X magnification at two reference points.(Figure 5) Readings thus obtained were subjected to appropriate statistical analysis

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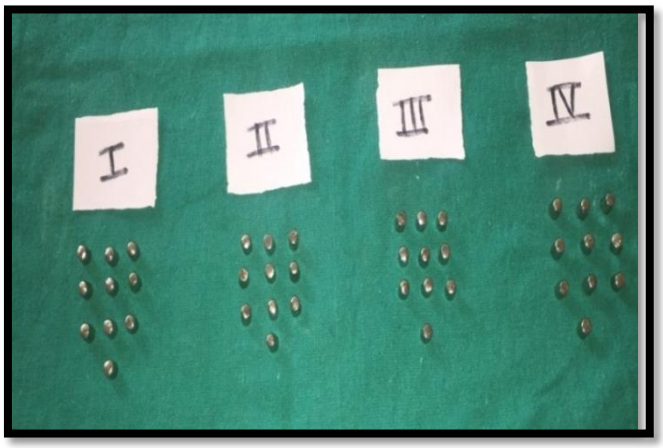

Figure 4 : Final Castings

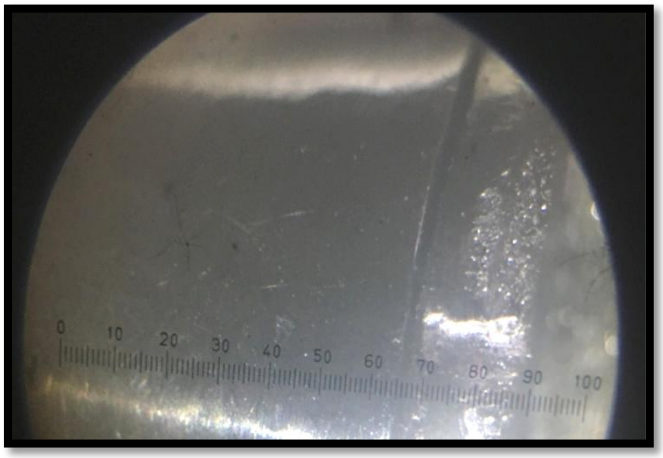

Figure 5 : Stereomicroscopic evaluation of casting seated on die

III. RESULTS:

The obtained results were statistically analyzed by MANOVA test. In the present study, $p<0.05$ was considered as the level of significance.

The results show the comparison of the mean value of the vertical marginal discrepancy values obtained for two of the four variables with each other by Mann Whitney U Test **(Table 1, Table 2, Table 3, Table 4)**

TABLE 1: COMPARISON OF CONVENTIONAL CASTING OF INLAY WAX AND AUTO-POLYMERIZING PATTERN RESIN

GROUPS	MEAN	S.D	P VALUE	SIGNIFICANCE
Inlay Wax	70.00	5.74	<0.001	HS
Auto-Polymerizing Pattern	89.37	7.24		

TABLE 2: COMPARISON OF ACCELERATED CASTING OF INLAY WAX AND AUTOPOLYMERIZING PATTERN RESIN

GROUPS	MEAN	S.D	P VALUE	SIGNIFICANCE
Inlay Wax	87.50	7.79	0.631	NS
Auto-Polymerizing Pattern	89.37	6.62		

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TABLE 3: INLAY WAX

GROUPS	MEAN	S.D	P VALUE	SIGNIFICANCE
Conventional Casting	70.00	5.74	<0.001	HS
Accelerated Casting	87.50	7.79		

TABLE 4: AUTOPOLYMERIZING PATTERN RESIN

GROUPS	MEAN	S.D	P VALUE	SIGNIFICANCE
Conventional Casting	89.37	7.24	0.971	NS
Accelerated Casting	89.37	6.62		

The results showed that on the comparison of the mean value of the vertical marginal discrepancy values obtained by four variables with each other ,the p-value obtained was less than 0.05, concluded by MANOVA Test, concluding **that there is highly significant difference between the four variables** (**Table 5).**

TABLE 5: COMPARISON OF CASTINGS FABRICATED WITH CONVENTIONAL AND ACCELERATED CASTING TECHNIQUE USING TWO TYPE OF PATTERN MATERIALS

GROUPS		MEAN	S.D	P VALUE	SIGNIFICANCE
Inlay Wax	Conventional Casting	70.00	5.74	<0.001	HS
	Accelerated Casting	87.50	7.79		
Auto-Polymerizing Pattern Resin	Conventional Casting	89.37	7.24		
	Accelerated Casting	89.37	6.62		

Mean marginal gap with conventional casting using inlay wax is 70µm whereas by accelerated casting is 87.5 µm. Mean marginal gap using autopolymerizing resin with conventional method is 89.37 µm which is similar to that obtained by accelerated casting technique i.e. 89.37 µm.
Since p value is less than 0.05 (≥0.001) which shows there is significant difference in between four variables.

IV. DISCUSSION

The procedure for fabrication of cast restoration is complex, involving various stages which may affect the dimensions and therefore the accuracy of fit of castings.The dimensional accuracy depends on various factors like method of fabrication as well as materials involved in the construction of prosthesis.

The conventional casting requires at least 1 hour bench set time for the investment. One stage burnout done traditionally to achieve complete burn out as well as thermal expansion. The entire process involving phosphate bonded investments takes longer time i.e. 2-4 hours; thus the demand for time saving was more. Thus accelerated casting was proposed. Accelerated casting technique have the ability to shorten the investing and casting process to 30 min, thereby improving productivity(2)

The first published attempt to accelerate the lost wax technique was done with the use of phosphate bonded investment for complete cast crown in 1988 by **Marzouk and Kerby** (4) . **Campagni et al** too tested the fit of dowel and cores made by noble alloy by an accelerated casting technique(5); similar study was conducted by **Bailey & Sherrad,** all concluded that phosphate bonded investment selected for accelerated casting technique produced castings with marginal gap comparable to that of conventional casting technique.(6)

Konstantoulakis and Schilling et al in 1998 evaluated the marginal fit and surface roughness of crowns made with conventional and accelerated casting technique and found that they were not significantly different.(7)
Traditionaly, patterns for dental castings have been formed from inlay casting wax. Though inlay waxes possess desirable properties such as ease of manipulation, predictable coefficient of thermal expansion, and absence of residual burn out. At the same time their thermoplastic characteristics can lead to distortion resulting from thermal changes and release of internal stresses.
Auto-polymerizing pattern resins, which are thought to be alternative pattern materials have been used since then for fabricating copings requiring greater dimensional stability. Auto-polymerization reduces the amount of time available for manipulation, but the rigidity and hardness of the auto-polymerized resin allows contouring to be performed with abrasive instruments The major disadvantage of acrylic resin is that it leaves residues after burn out and it has high polymerization shrinkage (exhibit shrinkage within 24 hours after being made).

The present study was carried out to evaluate the marginal discrepancy of castings fabricated with conventional and accelerated casting technique by using two type of pattern materials. A total of 40 castings

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were made in four groups with two types of casting techniques and two type of pattern materials. The vertical marginal accuracy of uncemented complete crown was assessed with the help of 40X magnification stereomicroscope at two reference points and readings were recorded and then subjected to statistical analysis. The mean gap for G1 is 70 µm, GII is 87.50 µm, GIII is 89.37 µm and GIV is 89.37 µm. The statistical analysis by **MANOVA test** indicated that difference in **vertical marginal discrepancy for castings fabricated in the four groups was statistically significant i.e. p≤ 0.05**($p \leq 0.001$).

The results concluded that castings made with inlay wax as pattern material had less marginal discrepancy than the auto polymerizing pattern resin material. **Iglesias** in 1996 stated that auto-polymerizing pattern resin had greater rigidity and hardness which allowed shaping of pattern to be performed with abrasive instrument but its disadvantage is high polymerization shrinkage i.e. the cause of greater marginal discrepancy in castings fabricated by auto-polymerizing pattern resin than inlay wax.(8)

The castings produced by conventional casting technique showed lesser vertical marginal discrepancy than accelerated casting technique. Longer burn out cycles were mainly the reason for lesser marginal discrepancy with conventional casting as compared to accelerated casting technique. **Schilling et al** stated that accelerated techniques might take advantage of characteristic exothermal setting reaction of phosphate bonded investment , this heat enhanced setting expansion continued uninterrupted as the mold was transferred into a pre heated furnace for thermal expansion. This might be the reason for marginal discrepancy of cast copings made by accelerated casting technique to be in clinically acceptable limit.(9)

However there are few limitations in this study. First and foremost, laboratory testing cannot exactly reproduce the clinical situations. Secondly, in this study, marginal discrepancy was measured without permanent cementation of cast copings, and it could potentially affect the marginal adaptation. Studies by **Hung et al** and **Quintas et al** have also stated that marginal accuracy increases significantly after cementation.(10)(11)

Thirdly in this study, direct view has been used to evaluate vertical marginal discrepancy**. Soreson** in 1990 introduced a standardized method for determination of marginal accuracy of crowns like direct view, cross sectional view, impression technique, explorer and visual view (12). This study used direct view to evaluate the vertical marginal discrepancy. The direct view method is easy, convenient, rapid because the crown is retrievable, unlike the cementation, embedment, and sectioning method, which causes destruction of the crown.

Lastly the results of accelerated technique, encourages further research to identify the factors that facilitate better marginal fit of the cast restorations. Also further research is needed for the better usage of pattern materials like light cure pattern materials or use of CAD/CAM to ensure consistency of patterns and newer techniques like Direct Metal Laser Sintering.

V. CONCLUSION :

The results showed that:

- The order of vertical marginal discrepancy obtained in this study :

a) Least mean gap was observed in castings made using inlay wax with conventional casting technique – GI-70 µm.

b) Moderate marginal gap was observed in castings made using inlay wax with accelerated casting technique – GII – 87.50 µm.

c) Maximum mean gap was observed in castings made using auto-polymerizing pattern resin with conventional and accelerated casting technique-GIII & GIV – 89.37 µm.

- The mean vertical marginal discrepancy of all cast copings obtained by four groups (GI, GII , GIII & GIV) were within the clinically acceptable limit.

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Sakshi Malhotra " COMPARATIVE EVALUATION OF MARGINAL DISCREPANCY OF CASTINGS MADE WITH CONVENTIONAL AND ACCELERATED CASTING TECHNIQUE USING TWO TYPES OF PATTERN MATERIALS " Quest Journals Journal of Medical and Dental Science Research 4.5 (2018): 11-17.

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