Original Article

International Journal of Dental and Health Sciences
Volume 02,Issue 03

EVALUATION OF MARGINAL FIT OF CAST METAL RESTORATION USING TWO DIFFERENT CASTING TECHNIQUES AND TWO DIFFERENT INVESTMENT MATERIALS

M.Rajakumar[1],C.Sabarigirinathan[2],K.Vinayagavel[3],P.Rupkumar[4], G.Sriramaprabu[5],Sunil kumar[6],V.Parimala[7],S.Vinayakam[8],S.Elavarasan[9]

[1](Associate professor), [2](Professor &HOD), [3](professor), [4,5](Associate professor), [6,9](PG Student), [7,8](Senior Assistant Professor) Department Of Prosthodontics, Tamil Nadu Government Dental College & Hospital, Chennai(600003), Tamil Nadu, India

ABSTRACT:

Purpose: To evaluate the marginal fit of cast crowns prepared by two different types of commercially available Investments materials and two different types of casting techniques.

Materials And Methods: Two different type of commercially available phosphate bonded investment were selected and cast metal copings were prepared on the type IV gypsum die. Alloy samples are prepared by using accelerated and conventional casting procedure. The metal copings were tried on their respective stone dies to check the marginal fit by using traveling microscope.

Results: The mean marginal gap of the Group I A samples is 0.028cm, Group I B samples is 0.021cm, whereas the marginal gap of Group II A samples is 0.018cm, Group II B samples is 0.018cm which are statistically significant at 5% level. It implies that the two casting methods namely conventional and Accelerated technique using two commercially available Phosphate bonded investment material has no statistically significant difference

Conclusion:

1) Marginal gap for casting made with accelerated technique showed no statistical difference when compared with a conventional casting group.
2) There is no statistical difference in the group I and group II for both technique of casting.

Keywords: Investment,Casting,Metal Crown

INTRODUCTION:

Accurate fit of the cast metal restoration in the master cast than in the patients mouth is highly a critical one for the successful practice of the fixed type of restorations. Conventional casting procedure usually takes longer time to obtain adequate expansion of mould space. Although it gives good results and adequate fit of the restoration, the time consumption is a sensitive factor in the present day practice. [1]

On the other hand the accelerated casting technique was introduced by Marzouk and Kerly in 1988, in this accelerated casting technique the time consumption to carry out this procedure is considerably reduced but the marginal fit of the cast restoration especially in long span replacement was thrown out into a

*Corresponding Author Address:Dr K Vinayagavel Email: vinayvela@rediffmail.com

debate. The special type of phosphate bonded investment material (Moldavest, Flexvest) is currently is used for accelerated casting procedure. [2, 3]

In the modern accelerated casting procedure it has to be analyzed that whether this expansion is achieved by the above mentioned methods is sufficient to compensate the cooling shrinkage. In this study apart from using two different casting procedures, two different investment material are also used to evaluate their ability by assessing the marginal fit of the cast metal restoration prepared by using them.

MATERIALS AND METHODS

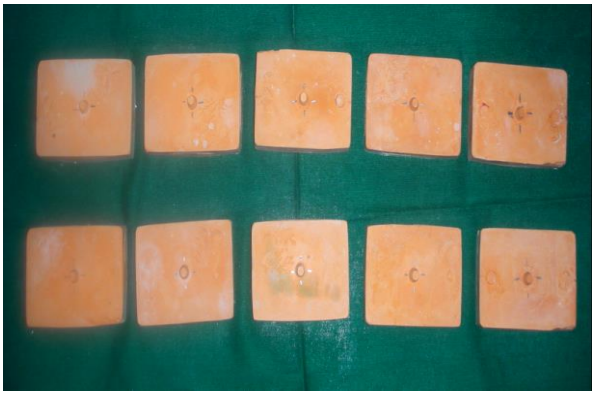
Base: A machined steel die is used to fabricate, gypsum models for the fabrication of wax pattern. The steel die simulated a prepared crown having the height of 6 mm and 6 mm diameter cervically with 10° axial wall taper. A steel ring is prepared height of 1 mm and width of 1mm to simulate the shoulder. This metal ring is inserted over the metal die already prepared represent, the crown.

Body: Body of dies split into two parts. Completely encircling the crown portion of base with opening in center 1mm larger in all dimensions than the crown in the base which provide uniform thickness forresin pattern. The body of the die has an opening on either side which help to orient with base of 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 are 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 uniform wall thickness of 1mm. The resin is poured until it overflow 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 stone die was measured using traveling microscope (x 50 magnification) with /µm accuracy.

The prepared patterns are basically divided into Group I and Group II representing two different types of investment materials.

S.No.	Group	Investment Material used	Sub Group	Casting Technique
1.	Group I	Moldavest	A B	Conventional Accelerated
2.	Group II	Flexvest	A B	Conventional Accelerated

Each group is further sub divided into sub Group I A and IB and sub Group IIA and Group IIB based upon the types of casting procedure namely conventional method and accelerated method. So the total number of 40 samples are divided and allotted 10 samples for each sub group.

Resin Pattern Of Stone Die Model

Investing Resin Pattern: Each pattern was invested after marginal refinement metal casting rings was used and lined with one non-overlapping layer of cellulose ring liner to get adequate expansion of investment to compensate for the casting shrinkage of metal copings. Resin pattern were coated with debubblizer and dried for 3 minutes to reduce the surface tension so that investment material comes in close contact with resin pattern.

Sixty grams of investment powder mixed with 13ml of investment liquid and were hand mixed for 20 seconds and followed by 90 seconds mechanical mixing and poured by using vibrator to prevent incorporation of air bubbles and to increase the density of mix. The investment were allowed to set in the casting ring for one hour for conventional casting procedure and 14 minutes for accelerated casting procedure as per the manufacturer's instructions.

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 were 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.

Temperature	Temperature Increase	Holding Time
23 – 270°C	7 - 10 C / minute	30 minutes
270 – 560°C	7 - 10 C / minute	20 minutes
560 – 750°C	7 - 10 C / minute	30 minutes

For Accelerated Technique:

For accelerated technique after investing the pattern, bench set time of 14 minutes were 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:

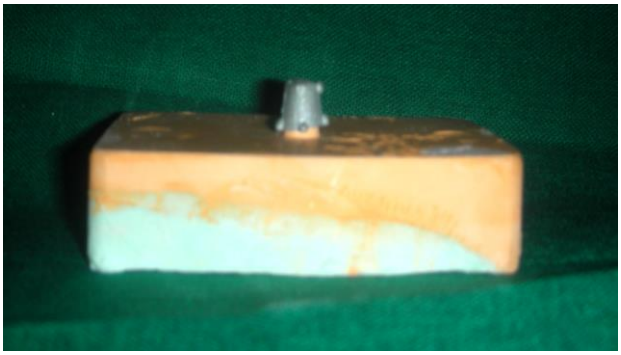
Casting for Group-I and Group-II after burnout procedure, were done in centrifugal casting machine. Nickel-Chromium, Pellets was used for the casting procedure and all casting were cooled to room temperature. After retrieving the cast copings from the investment, they were carefully examined and the spures were cut with separating discs. All the cast coping were then sand blasted with 50µm aluminium oxide particles under 30 Psi pressure.

Casting were then cleaned with distilled water in an ultrasonic cleaner for 12 minutes spraying with an air-water syringe and the dried.

MEASUREMENT OF MARGINAL GAP:

Each casting was seated on its respective stone die and checked for proper fit.

Travelling microscope was used with 50x magnification to measure the gap between the margins of casting and top of the stone die platform. Microscopic preparation measurements were made at four predetermined points and the marginal gaps were measured to the nearest micron on each casting.



Cast Crown In Stone Die Model

Cast Crowm In Traveling Microscope For Evaluation

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. 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.

Table 1 (Group I – Moldavest)

S.No	Subgroup – A	Subgroup – B
	Marginal Gap (cm)	Marginal gap (cm)
1	0.03	0.01
2	0.02	0.02
3	0.03	0.02
4	0.01	0.02
5	0.03	0.02
6	0.04	0.01
7	0.02	0.02
8	0.03	0.03
9	0.04	0.01
10	0.03	0.02

Table 2 (Group II – Flexvest)

S.No	Subgroup – A	Subgroup - B
	Marginal Gap (cm)	Marginal gap (cm)
1	0.03	0.01
2	0.03	0.02
3	0.03	0.02
4	0.02	0.01
5	0.01	0.02
6	0.02	0.01
7	0.02	0.02
8	0.02	0.02
9	0.02	0.02
10	0.01	0.03

Table 3 (Mean and Standard Deviation of Group I – Moldavest)

Sub Group	Marginal Gap in cm		P value
	Mean	SD	
Group I A	0.028	0.009	0.011*
Group I B	0.018	0.006	

Table 4 (Mean and Standard Deviation of Group II – Flexvest)

Sub Group	Marginal Gap in cm		P value
	Mean	SD	
Group IIA	0.021	0.007	0.342
Group II B	0.018	0.006	

Table 5 (Mean and Standard Deviation of Conventional Technique)

Investment	Marginal Gap in cm		P value
	Mean	SD	
Moldavest	0.028	0.009	0.077
Flexvest	0.021	0.007	

Table 6 (Mean and Standard Deviation of Accelerated Technique)

Investment	Marginal Gap in cm		P value
	Mean	SD	
Moldavest	0.018	0.006	1.000
Flexvest	0.018	0.006	

INTERPRETATION OF RESULTS

Table 1and 2 shows the marginal fit discrepancy of cast crown in relation to two different types of casting techniques with two commercially available Phosphate bonded investment material

Table - 3 shows the of marginal gap mean value of Group I samples. Group I A conventional technique with Moldavest

has a mean value of 0.028 and Group I B Accelerated technique with Moldavest has a mean value of 0.018. So there is a difference between the two sub groups of about 0.010.

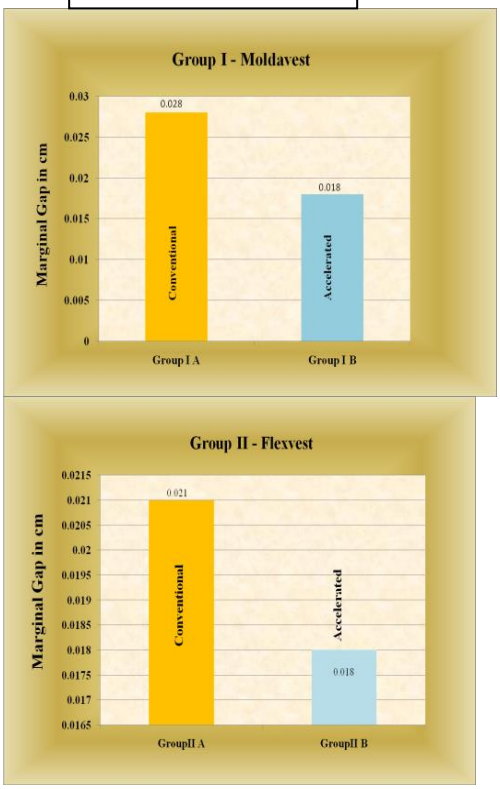
Table - 4 shows the of marginal gap mean value of Group II samples. Group II A conventional technique with Flexvest has a mean value of 0.021 and Group II B Accelerated technique with Flexvest has a mean value of 0.018. So there is difference between the two sub groups of about 0.003.

Table - 5 shows the Group I A has a marginal gap mean value of 0.028 and Group II A has a mean value of 0.021, so there is no significant difference between the two types of investment material by conventional casting technique.

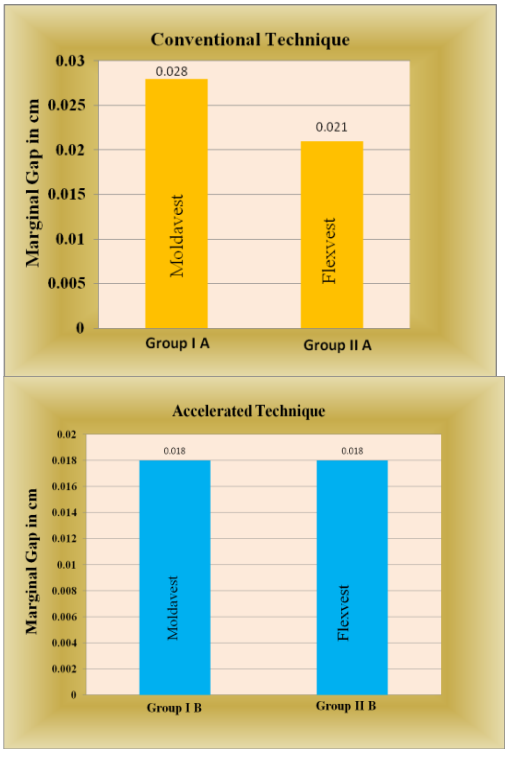
Table - 6 of shows the Group I B has a marginal gap mean value of 0.018 and Group II B has a mean value of 0.018, so there is no significant difference between the two types of investment material by Accelerated casting technique.

This study implies that the two casting methods namely conventional and accelerated technique using two commercially available Phosphate bonded investment material has no statistically significant difference.

Bar Diagram



For Table 3



For Table 5

DISCUSSION:

Marginal integrity of cast metal restoration is one of the key factors to 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.[4]

Lombardas explained the importance of compensation for shrinkage of solidifying alloy by investment expansion. He stressed the importance of the step is success for a cast restoration. Morey states that the shrinkage can be compensated by setting expansion, hygroscopic expansion and thermal expansion of the investment.

Distortion of the wax pattern, amount of thermal expansion and technique of wax elimination are found to be much important to produce good marginal fit of a cast restoration.[5] In the present study, only two variables i.e., casting technique and investment material are taken for consideration. The result of conventional casting technique and accelerated casting technique on the accuracy of marginal fit is analyzed.

Janzo-takahazi claims pattern resin have high rigidity, resist distortion on removal from the die and during investing procedure. Resin pattern might suppress the setting expansion towards the center of the mold and also it burns out without any residue.[6]

Rad. K. Morrow mentions that phosphate bonded investment can resist higher temperature and higher stresses during casting without breakage. Nickel chromium alloy for porcelain application and phosphate bonded investment are taken in the present study to evaluate the marginal accuracy. Two commercially available phosphate bonded investment materials are used in this study to find out the good marginal fit. Earnshaw stated that wet cellulose ring liner provide better space for the expanding investment,so wet cellulose ring liner is used.[7]

Flexvest and Moldavest are the two different type of phosphate bonded investing materials have been subjected to conventional casting technique and accelerated casting technique as per manufacturer's instructions.

Konstantoulakis et al followed conventional burn out technique in which the temperature was raised at a rate of 8° C per minute up to 427° C where it was held for 30 minutes. A rate of 14° C per minute was used for second cycle upto815° C. He also tried the accelerated casting technique. In accelerated casting technique the ring was placed directly in 815° C preheated oven for 15 minutes.[8]

Janzo Takahashi et al discussed the setting expansion and thermal expansion occur more in the vertical direction when compared to the horizontal direction.[6] 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

vertical direction by using traveling microscope.[8, 9]

The mean marginal gap of the Group I A samples is 0.028cm, Group I B samples is 0.021cm, whereas the marginal gap of Group II A samples is 0.018cm, Group II B samples is 0.018cm which are statistically significant at 5% level. The various authors who had done this type study have stated as follows, Christensen 74 µm, Dedmon 104 µm, Mclean 120 µm. However this marginal gap is considered to be clinically acceptable.

Schilling et al states that marginal gap of conventional casting is 49.3 µm (0.0493cm), while the marginal gap of accelerated technique showed no statistical difference when compared conventional casting group.[9]

In the present study resin patterns are used and these resin patterns offer physical resistance to the expanding investment, so the setting expansion initially would have taken place only in the external direction. Later on the expansion takes place in full intensity in the mold to compensate the solidification shrinkage. Shrinkage in the present study would be of external expansion of the investment during setting of investment and both internal and external expansion during thermal expansion.[6]

As far as the study is concerned the marginal gap found to be slightly more in conventional casting technique than accelerated casting technique. This difference in the results of the two casting technique could be attributed to

1. Though the temperature is gradually raised as per the manufacturer's instruction the casting was performed at 750° C which is the temperature prescribed by the manufacturer.

2. In accelerated casting technique the casting was performed at 850° C which is 100° C more than conventional technique and this increased temperature could also have been a reason for the less marginal gap in accelerated technique.

As far as the two different brands of phosphate bonded investment material is concerned, no significant difference was noticed between them, with respect to their quality of thermal expansion.

From the results of this study it was observed that the accelerated casting technique can also be taken into account along with conventional casting procedure. More over this study was performed with only single tooth restoration. It will be interesting and it may bring about more information if this study is proposed to a three unit fixed partial denture. Hence further an elaborate study is emphasized before confirming the accelerated casting technique is as good as conventional casting technique.

CONCLUSION:

Within the limitations of the present study the following conclusion can be arrived.

1. Marginal gap for casting made with accelerated technique showed no statistical difference when compared with a conventional casting group.

2.There is no statistical difference in the group I and group II for both technique of casting.

3.The methods used for accelerating the casting procedure are technique sensitive. More variation in the procedure can cause casting defects such as fins, porosity and nodules.

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:

1. Assif D, et al. Comparison of methods of clinical evaluation of the marginal fit of complete cast gold crowns: J Prosthet Dent. 1985 Jul; 54(1): 20 – 4.
2. Anusavice.K.J. Phillips Science of Dental Materials. Saunder's Elsevire Publications. Eleventh Edition.p563-617
3. Craig RG Restorative dental materials 10th Edition St.Louis, Mosby Co. chapter 16 437-64.
4. Milan F.M et al. Influence of casting method on marginal and internal discrepancies of complete cast crowns: Braz Dent J. 2004; 15(2): 127-32.
5. Michio Ito et al. Effect of selected physical properties of waxes on investments ad casting shrinkage: J Prosthet Dent 1996; 75: 211-6.
6. Junzo takahashi et al Non uniform vertical and horizontal setting expansion of a phosphate bonded investment. J.Prosthet.Dent 1999; 81; 386-91.
7. Earnshaw R. The effect of casting ring liners on the potential expansion of a gypsum-bonded investment. J Dent Res. 1998 Nov; 67(11): 1336-70.
8. Efstratios Konstantoulakis et al. Marginal fit and surface roughness of crowns made with accelerated casting technique: J Prosthet Dent 1998,80: 337-45.
9. Elaine. R. Schilling et al. Marginal gap of crowns made with a phosphate bonded investment and accelerated casting technique: J Prosthet Dent 1999; 81: 129-34.