Research Article

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Evaluation of Vertical Marginal Discrepancy of Deep Chamfer Finish Line in Metal Copings Fabricated by Conventional & Accelerated Preheated Cycle for Casting

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ABSTRACT

Background: Various materials and techniques have been used for complete crown fabrication. Conventional method of casting & investing requires around 2-4 hours, which includes minimum 1 hour of bench set for the invested ring & 1-2 hours for preheating cycle. The whole process is time consuming. This study aims to evaluate & compare vertical marginal discrepancy of deep chamfer finish line in metal copings fabricated by conventional & accelerated preheated cycle for casting.

Materials and Methods: 60 stone dies were poured from impression made with master die having deep chamfer finish line. Conventional & accelerated method of casting were performed according to manufacturer's recommendation. Each casting & its respective stone die were examined for vertical discrepancy at 4 predetermined sites. Mean of both groups were compared with t-test.

Result: Mean value of vertical marginal discrepancy for conventional group was 33.3 microns & for accelerated group was 37.8 microns.

Conclusion: The vertical marginal discrepancy of Ni-Cr single PFM copings obtained by employing conventional casting technique & by accelerated casting technique was statistically insignificant.

Keywords: Accelerated casting, Casting, Marginal Discrepancy, Marginal fit, Metal copings, Phosphate bonded investment.

INTRODUCTION

Lost wax technique introduced by Taggart in 1907, has changed the face of fixed prosthodontics. Though there has been advancement & innovations in dentistry in the past few decades, lost wax technique to carry out dental casting procedure still predominates.[1,2,3] The time required for conventional investing & casting procedure is around 2-4 hours, which includes minimum of 1 hour of bench set for the invested ring & 1-2 hours for preheating cycle. Newer materials promise reduction in time of the preheating cycle after investing the wax patterns. The first published attempt to accelerate the lost wax technique, with the use of phosphate bonded investment was made in 1988 by Marzouk and Kerby[2,4]. The design of the margin preparation affects fit of castings. Shoulder, shoulder with bevel & deep chamfer finish lines are most commonly advocated for metal ceramic

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restorations[5,6,7]. Clinically acceptable marginal discrepancy varies from 30µm to 200 µm[8]. According to ADA specification no.8, marginal adaptation of cemented castings should be in the 25 µm range. This study evaluates & compares the vertical marginal discrepancy of metal copings having deep chamfer finish line fabricated by conventional & accelerated preheated casting technique.

MATERIAL & METHODS

A. Fabrication of custom-made brass master dies & stone dies

Master die with deep chamfer finish line was fabricated using CNC machine (DX200; Jyoti, India) to simulate crown preparation (Fig.1). Brass metal die with deep chamfer was duplicated using addition silicone elastomeric impression material (Aquasil soft putty and Aquasil LV, Dentsply, Germany)) and poured in type IV dental stone (Kalrock, Kalabhai Karson Pvt. Ltd, Mumbai, India) for the fabrication of working dies (Fig.2). Sixty stone dies were obtained & divided into two groups, having thirty dies each. Marginal discrepancy was evaluated with the help of stereomicroscope.

B. Wax pattern fabrication

Dipping wax (DFS,Germany) was melted in a wax melting pot and held at temperature of 90°F during wax pattern fabrication. Stone dies were dipped in the molten wax once so as to achieve minimum thickness of 0.3-0.5-mm in axial and occlusal region. The patterns were checked for even thickness of wax using Iwanson wax gauge & modifications were made as per requirement. Sharp lines were inscribed on the wax patterns & stone die margin with B.P blade no.15 on four sides. This helps in relocating sites for the measurements of marginal discrepancy. The patterns were retrieved and margins refined with the use of a stereomicroscope at 40X magnification immediately before spruing and investing (Fig.3). Preformed wax sprue of 8-gauge diameter was attached to the wax pattern with a reservoir 3 mm from the pattern end of the sprue. The sprue was attached to the pattern at an angle of 45°.

C. Investing the wax pattern

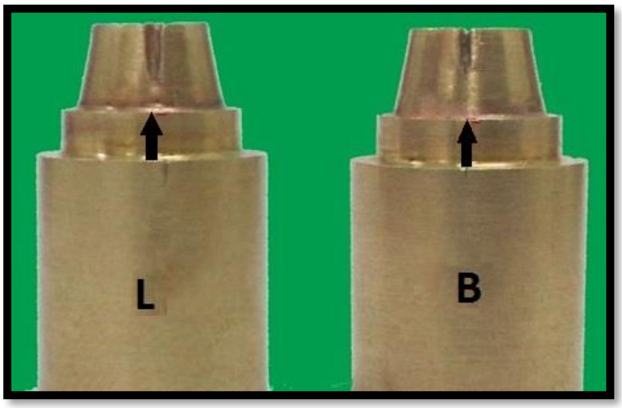


Fig 1: Metal Die.

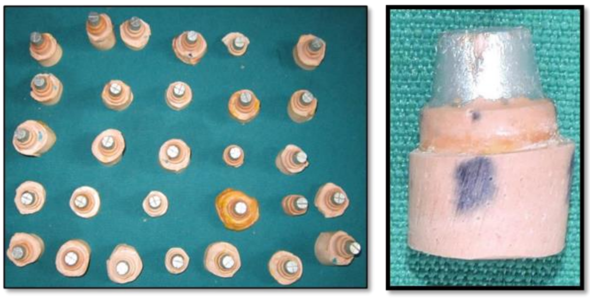


Fig 2a and 2b: Working stone Dies.

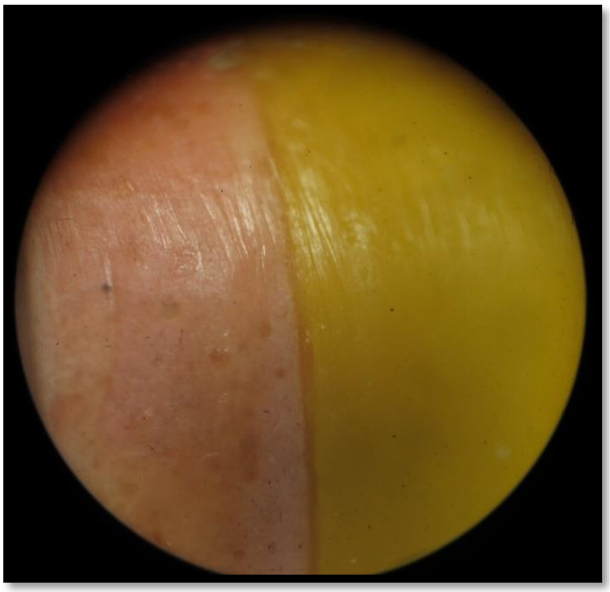


Fig 3: Wax Pattern under microscope.

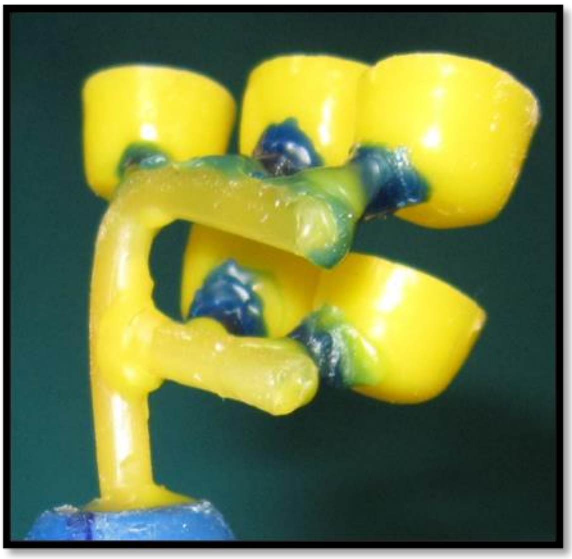


Fig 4: Spruing.

Fig 5: Metal casting.

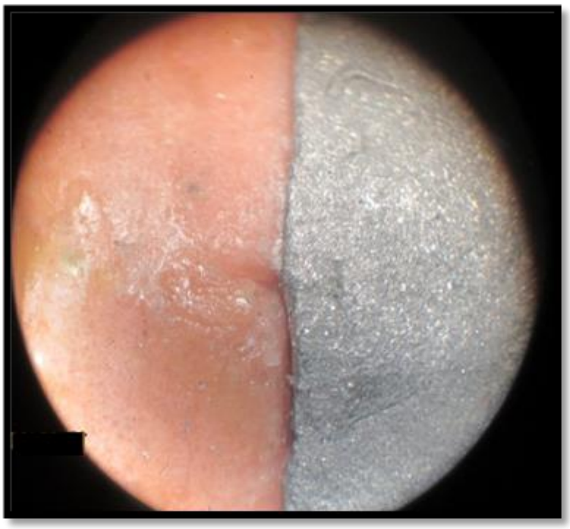


Fig 6: Metal casting seated.

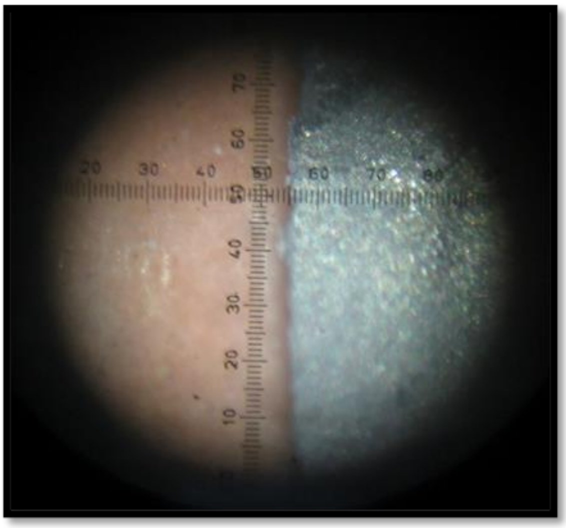
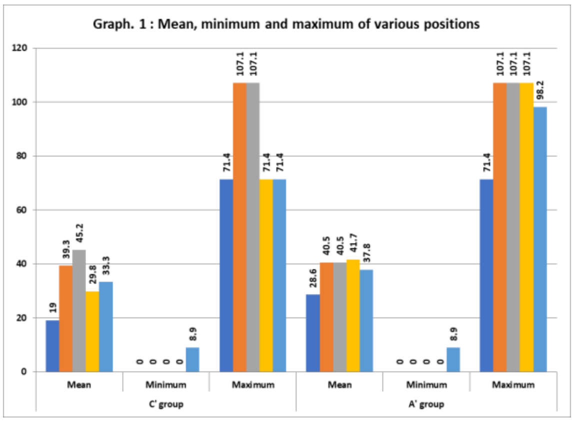


Fig 7: Metal casting under stereomicroscope.



Graph 1: Mean, minimum and maximum of various positions.

Table 1: Mean, range and standard deviation of the conventional group (in microns).

Parameter	Mean	Min	Max	±SD
Site I	19.0	0.0	71.4	27.7
Site II	39.3	0.0	107.1	19.6
Site III	45.2	0.0	107.1	32.4
Site IV	29.8	0.0	71.4	29.8
Pooled	33.3	8.9	71.4	18.6

Each wax pattern was immediately invested after marginal refinement to minimize distortion. Ringless casting system was used. Powder:liquid ratio & mixing of investment was done according to manufacturer's recommendation. The invested pattern was allowed to bench set for 60 minutes for conventional casting & 15 minutes for accelerated preheated casting.

D. Wax pattern elimination or burnout

After a 60-minute bench set time, the set investment mold was placed in burnout furnace for conventional group. Burnout of the wax pattern was done using a programmed heating technique, i.e. the ring was kept in the furnace at room temperature and was heated continuously till 430°C at the rate of 8°C/min and held for 30 min at 430°C. Then, temperature was raised to 815°C at the rate of 14°C/min and held for 60 min at 815°C. Bench set time for accelerated group was kept for 15 minutes. The set investment mold was placed in preheated burnout furnace maintained at 920˚C for 20 min which was adequate for complete elimination of wax.

E. Casting

Casting was performed in an induction casting machine quickly to prevent heat loss from the ring. Ni-Cr alloy was heated sufficiently till the alloy ingot turned to molten state. Then crucible was released and centrifugal force ensured the completion of casting procedure. For every casting procedure, fresh alloy was procured. Investment was allowed to cool down to room temperature. The casting procedure followed was same for all the 60 test samples of both the groups. A total of 60 castings were thus made to obtain cast copings for the evaluation (Fig.4).

F. Divesting and finishing the cast coping

Following casting, the investment mold was bench cooled to room temperature. The investment mold was cleaved along its long axis, and the casting was lifted free. Adhered investment was removed from the casting by sandblasting with 50μm alumina at 80 psi pressure. The sprue was removed with an abrasive disc. Internal surface of castings were inspected visually, under stereomicroscope. Castings without any nodule & voids were selected. This procedure was followed for each of the samples of the test groups.

G. Measurement of marginal discrepancy

Each casting was seated on its respected die with finger pressure. Microscopic measurements were recorded at 40X magnification, perpendicular to the axial wall of die and parallel to path of withdrawal of the metal copings, with stereomicroscope.

Table 2: Mean, range and standard deviation of the accelerated group (in microns).

Parameter	Mean	Min	Max	±SD
Site I	28.6	0.0	71.4	23.7
Site II	40.5	0.0	107.1	32.1
Site III	40.5	0.0	107.1	39.5
Site IV	41.7	0.0	107.1	37.6
Pooled	37.8	8.9	98.2	20.8

Measurements were taken from coping margin to the die margin for recording vertical marginal discrepancy. Marginal discrepancies were measured to the nearest micron on each casting at the 4 predetermined sites 90^0, 180^0, and 270^0, $360^{\ 0}$ on the base of the die from anti-rotational notch. The same procedure was followed to record the vertical marginal discrepancy for each of the 60 test samples belonging to each test group. The measurements thus obtained were tabulated and statistically analyzed.

RESULTS

All 60 metal copings with deep chamfer finish line & two different casting techniques were tested for marginal discrepancy by using a stereomicroscope. Measurements were recorded in four predetermined sites. Table 1 & 2 represent vertical marginal discrepancy of casting made by conventional casting & accelerated preheated casting technique respectively. Mean, range and standard deviation are listed. An unpaired t- test was used to compare the mean between the groups (Table 3).

The mean vertical marginal discrepancy of deep chamfer finish of PFM copings obtained by employing conventional casting technique was 33.3 μm while that obtained by accelerated casting technique was 37.8 μm. The statistical analysis by "t" test indicates that the difference in the marginal gap measurements for the two techniques showed $p>0.001(0.384)$. This denotes that the difference is statistically insignificant, and it indicates that castings produced by conventional casting technique with two stage wax elimination technique & by using accelerated casting technique was nearly similar.

DISCUSSION

Accuracy of the marginal fit is one of the criteria for acceptance of a dental casting & for longevity of restoration. The margin of a casting should be closely adapted to the prepared abutment tooth margin. Discrepancy between the margin of casting & the tooth can lead to caries formation, cement breakdown, bacterial plaque accumulation, periodontal disease, sensitivity, and inadequate support for gingival tissue [5,9,7,11]. Fixed partial dentures are fabricated by using conventional casting technique, which usually requires 1 hour bench set for investment followed by a two stage wax elimination, temperature is increased from room temperature to 430 ° C and held for 30 min then increased to 815 °C and held for 60 min, finally raised to 850 °C for Ni-Cr alloy before casting is done. This whole process is time consuming because it requires approximately 2-4 hours for completion [2,3,4,9]. Accelerated technique was promoted as an acceptable method for cast post & core restorations by Bailey & Sherrard[4], & Camagni WV[39]. Konstantoulakis E et al[2] & Schilling ER et al[3] have evaluated marginal gap of crowns made with a phosphate-bonded investment & accelerated casting method by using high noble alloy & found that there was no significant difference between the two. In the present era, nickel chromium base metal alloy is most commonly used for the casting. Mohan TK et al [56], Premlatha A et al[59], Tannamala PK et al[60], Alex D et al[61], have evaluated dimensional accuracy of single full coverage cast restoration made with accelerated casting technique by using Ni-Cr alloy & concluded that marginal discrepancy of castings made by accelerated casting technique were within the clinically acceptable limits. The design of the margin preparation affects fit of castings. This study was conducted to compare the vertical marginal discrepancy of deep chamfer finish line of PFM (Ni-Cr) copings fabricated by conventional and accelerated casting method. Sparse studies have been published that evaluated dimensional accuracy of single full coverage cast restoration made with accelerated casting technique by using Ni-Cr alloy. The manufacturer of the phosphate bonded investment used in this study recommends that the investment can be used for an accelerated as well as for conventional casting technique with two stage wax elimination. Hence, this material was chosen for investing the wax patterns for all the test groups in this study.

CONCLUSION

The vertical marginal discrepancy of Ni-Cr single PFM copings obtained by employing conventional casting technique & by accelerated casting technique was statistically insignificant. Deep chamfer finish line has better marginal adaptation than shoulder finish line & should be preferred in clinical situation wherever possible. Conventional & accelerated casting technique can be successfully used to achieve optimum result in the casting as the discrepancies are well within the acceptable limit. Accelerated casting technique provides a time saving, cost-effective technique for fabrication of single unit casings for metal or metal ceramic crowns. Further research is needed to determine the effect of accelerated casting on multiple unit casting & effect of finish line design on horizontal gap and internal adaptation.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

REFERENCES

1. Schneider RL. A one appointment procedure for cast post and core restorations. J Prosthet Dent 1994;71: 420-2.

2. Konstantoulakis E, Nakajima H, Woody RD, Miller AW. Marginal fit and surface roughness of crowns made with an accelerated casting technique. J Prosthet Dent 1998;80:337-45.

3. Schilling ER, Miller BH, Woody RD, Miller AW rd, Nunn ME. Marginal gap of crowns made with a phosphate bonded investment and accelerated casting method. J Prosthet Dent 1999; 81:129-34.

4. Bailey JH, Sherrard DJ. Post-and-core assemblies made with an accelerated pattern elimination technique. J Prosthodont 1994; 3:47-52.

5. Silken D: Indirect evaluation of the marginal fit of dental castings. J Prosthodont 1992;1(2):95-100.

6. Teteruck WR, Mumford G; The fit of certain dental casting alloys using different investing materials and techniques. J Prosthet Dent 1966;16(2): 910-927.

7. Shiratsuchi H, Komine F, Kakehashi Y and Matsumura H. Influence of finish line design on marginal adaptation of electroformed metal-ceramic crowns. J Prosthet Dent 1966;16(2) 910-927.

8. Blackman RB. Evaluation of the dimensional changes and surface roughness of gold crowns cast with rapidly prepared phosphate bonded investment: A pilot study. J Prosthet Dent 2000; 83:187-93.

9. Lombardas P, Carbunaru A, McAlarney ME, Toothaker RW. Dimensional accuracy of castings produced with ringless and metal ring investment systems. J Prosthet Dent 2000; 84:27-31.

10. Amini P, Absalo A. Effect of preparation design on marginal gap of matal ceramic restorations. J. Med. Sci 2008; 8:665-68.

11. Schwartz IS. A review of methods and techniques to improve the fit of cast restorations. J Prosthet Dent1986;56(3):279-283.

12. Shillingburg HT, Hobo S, Whittsett LD, Jacobi R, Brackett SE. Fundamentals of Fixed Prosthodontics. 3rd ed. Chicago: Quintessence Publication; 1997.p. 365-83.

13. Rosensteil SF, Land MF, Fujimoto I. Contemporary Fixed Prosthodontics.4th ed. St. Louis: CV Mosby, Inc.; 2007. p. 411-5.

14. Anusavice KJ. Phillip's. Science of Dental Materials. 11th ed. Philadelphia: W.B. Saunders; 2003. p. 283-350.

15. Fusayama T. Factors and techniques of precision casting. Part I. J Prosthet Dent 1959; 9:468-85.

16. Schnell RJ, Mumford E, Phillips RW. An evaluation of phosphate bonded investments used with a high fusing gold alloy. J Prosthet Dent 1963;13(2):324-

17. Mahler DB, Ady BA. An explanation for the hygroscopic setting expansion of dental gypsum products. J Dent Res 1963; 39:578.

18. Fusuyama T, Kimiko I, & Hosoda H. Relief of resistance of cement of full cast crowns. Journal Prosthet Dent. 1964;14(1):95-106.

19. Kelly G P. study of porosity and voids in dental gold castings. Dent Research 1970; 49:986-993.

20. McLean JW, von Fraunhofer JA. The estimation of cement film thickness by an in vivo technique. Br Dent J 1971; 131:107-11.