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Original Research

An In-Vitro Study to Compare and Evaluate the Marginal Adaptation of Metal Copings Casted Using Metal Ring and Ring less Investment System

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ABSTRACT

Purpose: The present study aims to to compare the marginal adaptation of single unit metal coping with the conventional casting technique using A metal ring and A technique that uses a ringless system using a stereomicroscope. **Materials and Methods:** A stainless steel master die assembly was fabricated simulating a prepared crown. 30 wax patterns were fabricated which were divided into two groups. 15 with metal ring investment system and 15 with ringless investment system and the marginal adaptation between the die and patterns were compared and measured using Optical stereomicroscope. **Results:** The mean marginal adaptation of group 1 copings was found to be 89.570±3.82µm and of group 2 copings were found to be 51.605±3.89µm with the difference being statistically highly significant (P< 0.001). Which shows the mean marginal adaptation was higher in Group 2 (ring investment system) as compare to Group 1 (metal ring investment system) **Conclusion** The marginal adaptation of the Metal copings obtained in ringless investment system more accurate than those of the metal ring investment system. The ringless investment system can produce better fiiting and acceptable single unit restorations in fixed prosthodontics.

Keywords: Metal ring investment system, Ringless investment system , marginal adaptation, phosphate-bonded investment.

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INTRODUCTION

The precise fit of a cast restoration determines its long term success by providing favourable mechanical (stability, resistance), biological (reduced plaque accumulation, minimal cement thickness, reduced marginal leakage), and static properties. The materials (wax, investment, alloy, metal casting ring) involved in the lost wax casting process undergoes shrinkage or expansion, which can result in the final restorations being under or oversized.[1]

Steel rings have been most frequently used for investing and casting dental restorations but they restrict the setting expansion of investment in the radial direction. The use of a ring liner compensates for the thermal expansion of the metal ring, but only to a limited extent. Ringless casting technique in removable and fixed prosthodontics attempts to solve the problem of anisotropic investment expansion. Ringless casting allow, setting expansion and thermal expansion of investment in the all direction thus giving better fitting casting. There is a need to compare the marginal adaptation a metal copings casted using the two type of investment technique.[2,3]

There is a dearth of literature about the fitting accuracy of castings done by ring and Ringless investment systems. This in-vitro study was therefore undertaken to compare the marginal fit of full coverage metal restoration made

on a single metal die using metal ring and ringless investment techniques,

MATERIAL AND METHOD

This study was conducted in Department of Prosthodontics, Crown & Bridge and Implantology, Rishiraj College of Dental Sciences and Research Centre, Bhopal in assistance with Department of Pathology, L.N. Medical College of Dental Sciences and Research Centre, Bhopal, M.P.

For fabrication of master die a stainless steel cylindrical pellet with 10 mm diameter and 20 mm length was used. The top 6mm length of the cylinder was precisely build with 6 degree taper upto a depth of 1.5mm. This was done to simulate an ideal porcelain fused metal crown preparation done on a molar crown. A shallow axial groove was given one of the milled surfaces for orientation of casting during seating. For ease of measurement, four reference marks were scribed 90 degree to each other, thus mimicking the buccal, lingual, mesial and distal areas on a root stump.[4,5]

A counter die was also fabricated in order to get duplicate wax pattern multiple times, this counter die was fabricated from a cylindrical stainless steel pellete with 15 mm diameter and 17 mm length [Figure 1].[4,5] On one of this surfaces a round cavity with 10.5mm diameter and 7mm depth was milled. This was done so as to allow the master die to fits snugly inside the counter die. Once fitted there was an even gap of 1.5mm between the milled surfaces of master die and counter die.[4,5]

A total of 30 wax patterns using pattern wax (Bego, Germany) were fabricated. Both milled surfaces of die and counter die were first lubricated by using die lubricant (DFS, Germany). The counter die was filled with the molten wax and the metal die was pushed inside the counter die until the demarcated mark to obtain wax patterns of uniform thickness.[4]

These wax patterns were then randomly divided into two groups of 15 patterns each group. Final pattern was checked for its marginal integrity with the finish line of the master die. Fabricated wax pattern divided into two groups with 15 wax pattern in each group.[4,5]

Group – 1: Representing metal ring investment system.
Group – 2 : Representing ringless investment system.

Following this the patterns were sprued to sprue formers (Bego, Germany of 2mm diameter) and then attached to the crucible former in the conventional manner..

The first group of 15 randomly selected pattern were invested using phosphate-bonded investment (Bellasun powder and Begosol liquid, Bego, Germany) as per the manufacturers instructions with a metal casting ring of 3cm diameter was used. A single layer of ceramic liner was adapted to the metal casting ring and moistened by dipping in a bowl of water, and the excess water was shaken away.[6] Once the investment material was poured inside the ring it was kept at room temperature for 1 hour to allow complete crystallization and setting expansion of investment material to take place.[1,2,3] Burn out was done as per manufacturers instructions.

The second group of remaining 15 patterns were invested with phosphate-bonded investment material (Bellasun powder and Begosol liquid, Bego, Germany) using an elastic ring of 3cm diameter as per the manufacturers instructions. After the pouring of investment material the mold was allowed to set for 10 minutes in order to achieve the initial set, after which the elastic ring was removed. These ringless molds were kept at room temperature for 2 to 3 hours to allow complete crystallization and setting expansion of investment material to take place.[1,2] Burn out was done as per manufacturer's instructions.

Casting was done using Nickel-Chromium alloy (bellabond plus) in an Induction Casting Machine (Pemax T–Bego, Germany) as per manufacturers instructions. The castings were recovered burs were used to remove the investment from the inner surface of the casting such as a thin layer of investment was left behind. Sandblasting was done to remove the residual investment and oxide layer.

The casted samples were seated on the metal die under finger pressure, and measured for marginal discrepancy between the metal die and the castings at four predemarcated areas on the metal die at the four sites (buccal, mesial, lingual, and distal areas). The measurement were done under a digital optical stereo microscope (Lynx, Laurance & Mayo, Japan) with SPI software (0.1 µm accuracy at 100X magnification) was used to visualize and measure the discrepancies [figure 1,2]. All measurements were executed by a single operator and the readings were tabulated and used for the statistical analysis.

Figure 1: Measurement Of The Marginal Discrepancy With Spi Software

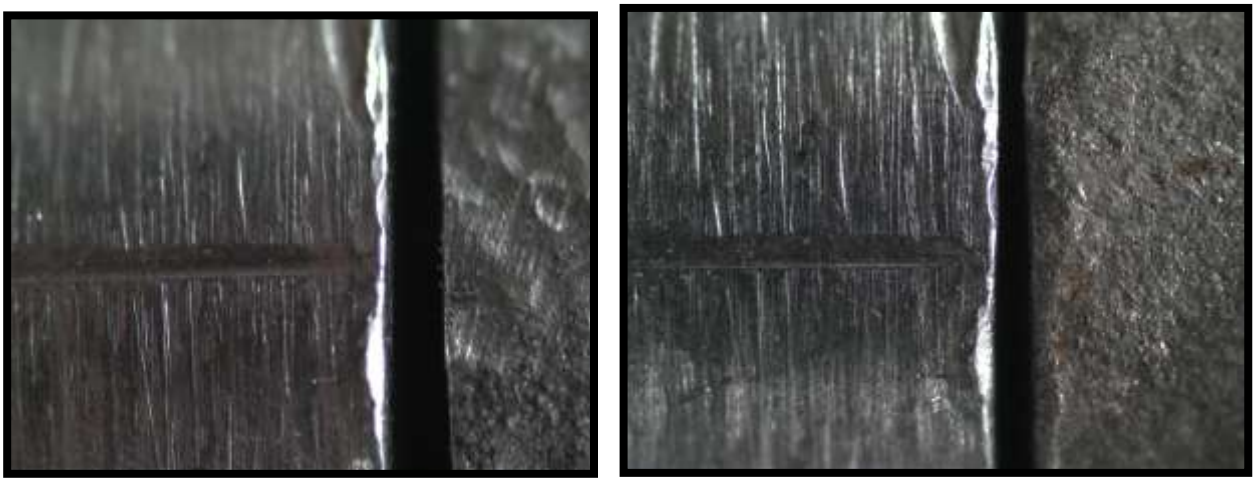

Figure 2: MEASUREMENT OF MARGINAL GAP OF GROUP 1 & GROUP 2 COPING USING OPTICAL MICROSCOPE

RESULTS

The comparison of mean marginal adaptation between copings in Group 1 & copings in Group 2 at all four area (Average).The mean marginal adaptation of Group 1 as metal ring investment system were found to be 89.570±3.82 and the mean marginal adaptation of Group 2 as ringless investment system were found to be 51.605±3.89. Student's t test was used for the comparison and statistically highly significant difference was found between both Group1 and Group 2. (P< 0.001). Which shows the mean marginal adaptation was higher in Group 1 as compare to Group 2. (table - 1)

Table 1: Comparison of Mean Marginal Discrepancy (µm) between four area in Group 1 & Group 2

AREA	Metal Ring Investment System.	Ringless Investment System.
BUCCAL	**91.120**	**53.493**
LINGUAL	**87.946**	**52.553**
MESIAL	**90.706**	**51.153**
DISTAL	**88.506**	**49.220**

At Meseal area the mean marginal adaptation of copings in group 1 were found to be 90.706±6.63 and the mean marginal adaptation of copings in group 2 were found to be 51.153±6.46. Student's t test was used for the comparison and statistically highly significant difference was found between both group 1 & group 2. (P< 0.001).(table 2). At distal area the mean marginal adaptation of copings in group 1 were found to be 88.506±6.42 and the mean marginal adaptation of copings in group 2 were found to be 49.220±5.74. Student's t test was used for the comparison and statistically highly significant difference was found between both metal ring & Ringless Investment System. (P< 0.001). (table 3).

Table 2: Comparison of Mean Marginal adaptation between Group 1 & Group 2 at Buccal Area.

		Mean Marginal Adaptation (µm)	
COPING	**Number**	**MEAN**	**SD**
Group 1	**15**	**91.120**	**5.94**
Group 2	**15**	**53.493**	**4.78**
Unpaired Student 't' Test		**19.090**	
Significance 'P' Value		**0.001(HS)**	

Table 3: Comparison of Mean Marginal adaptation between Group 1 & Group 2 at Lingual Area.

		Mean Marginal Adaptation (µm)	
COPING	**Number**	**MEAN**	**SD**
Group 1	**15**	**87.946**	**5.02**
Group 2	**15**	**52.553**	**5.04**
Unpaired Student 't' Test		**19.268**	
Significance 'P' Value		**0.001(HS)**	

Table 4: Comparison of Mean Marginal adaptation Group 1 & Group 2 at mesial Area.

		Mean Marginal Adaptation (µm)	
COPING	**Number**	**MEAN**	**SD**
Group 1	**15**	**90.706**	**6.63**
Group 2	**15**	**51.153**	**6.46**
Unpaired Student 't' Test		**16.530**	
Significance 'P' Value		**0.001(HS)**	

Table 5: Comparison of Mean Marginal adaptation between Group 1 & Group 2 at Distal Area.

		Mean Marginal Adaptation (µm)	
COPING	**Number**	**MEAN**	**SD**
Group 1	**15**	**88.506**	**6.42**
Group 2	**15**	**49.220**	**5.74**
Unpaired Student 't' Test		**17.659**	
Significance 'P' Value		**0.001(HS)**	

DISCUSSION

Fixed Prosthodontics has become a major part of current restorative dentistry.[8] Various alloys and techniques have been introduced for the casting of the fixed partial dentures.[7] Ever escalating cost of gold has made a paradigm shift to the use of base metal alloys ever since their introduction to the profession over 50 years.

Although the ringless casting technique is in use in fixed prosthodontics and implant prosthodontics, there are few investigations about the technique in the literature, and the accuracy of the castings depends on the skills of the technicians and is clinically determined by the dentists. There is no scientific data to support the use of this technique. This study is a pilot study (clinically oriented) to determine whether the technique produces acceptable results. Although the metal ring technique is clinically acceptable and allows for the fabrication of accurate casts, the metal ring restricts the setting and thermal expansion of the investment,[4,8,9] which is necessary to compensate for the shrinkage of the metal on solidification. To overcome this expansion restriction, a soft liner is used.[5,10]

The ringless technique for investing and casting has been in use for many years for the fabrication of frameworks for removable partial dentures.[11] It was introduced in fixed prosthodontics technology.[12] With the use of a ringless technique, the restriction of thermal expansion that is associated with the presence of the metal ring is avoided. In this study, the margin discrepancy of castings produced the ringless technique and the conventional technique using the metal ring were compared.[13,14] Throughout our study, the recommendations of the manufacturers were followed and the adjustment of the internal surfaces of the castings was not performed. The results indicate that, within the conditions of the study, the castings produced by the ringless technique fit better than the castings, using the conventional metal ring technique.[15,16]

Clinical tolerance limits for the fit and marginal adaptation of a cast restoration are actually not known. However, several investigations reported that marginal gaps in cast crowns of up to 74 µ, 104 µ, or 120 µ are considered to be clinically acceptable. From the results and condition of the study, the hypothesis that the ringless technique allows more expansion for the investment and therefore produces casting with better adaptation can be verified. Copings fabricated by metal ring investment system were found to have more marginal discrepancy as compare to ringless investment system but this discrepancy found was well under the clinically acceptable limits In the present study mean mean marginal adaptation was found was For the copings of group-1 to be be 89.570±3.82µm and for Group 2 It was found to be 51.605±3.89µm. In both the groups, the values are well within the clinical tolerance limits (120 µm).

The main limitations of the present study include the use of single unit wax pattern, the use of a single brand phosphate bonded investment and ringless investment system, and the use of 2D method of casting accuracy determination. Further investigations can include multiple brands of phosphate-bonded investment and ringless casting system, study of the effect of cementation and porcelain veneer accuracy of multiple unit restoration fabricated with the ringless casting technique. Future study may also determine the 3D accuracy of implant supported and removable partial denture framework made by the ringless investment system.

CONCLUSION

Under the conditions of this study the following conclusions were drawn:

1. The marginal discrepancies of the metal copings obtained in both ring and ringless investment system were within clinically acceptable limits.
2. The marginal adaptation of the metal copings obtained in ringless investment system was significantly better than copings obtained by conventional ring investment system.
3. There was no significant difference in the vertical margin discrepancy at the buccal, lingual, mesial and distal surfaces within the same group.
4. The ringless technique was clinically acceptable and can be used for the fabrication of fixed prosthodontic restorations. Further investigation should be conducted to be determined whether it can be used for the fabrication of implant-supported prostheses.

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