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Original Research

Stereomicroscopic assessment of the marginal fit of metal copings fabricated by three different commercially available porcelain fused to metal alloys: An *in vitro* (Original Research) Study

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ABSTRACT:
Aim: To assess the marginal accuracy of metal margins fabricated with three commonly used alloys in the field of Prosthodontics. Marginal assessments were completed by using stereomicroscope. **Materials and Methods:** Total thirty samples were studied wherein ten samples were evaluated for each metal. All thirty metal copings were made on a customized metal die. In this study, authors selected three commercially available alloys used in the field of Prosthodontics i.e.; Mealloy, Star Loy N, Bellabond. All metal copings were made by routine investment and casting methods. Divesting and finishing was also done by standard methods. The customized die was prepared similar to the shape and dimension of mandibular first molar preparation. Marginal assessments were completed by using stereomicroscope at four different surfaces. Samples were placed at the testing platform of the microscope for space assessment and measurement. Mean gap value of the four tested metal surfaces were considered definitive for that sample. **Statistical Analysis and Results:** All the gathered details and values were tabulated and sent for statistical evaluation using statistical software Statistical Package for the Social Sciences version 21. The vertical marginal discrepancy data obtained were tabulated. For group I (Mealloy) copings, the mean vertical discrepancy was 58.053. For group II (Star Loy N) copings, the mean vertical discrepancy was 32.160. For group III (Bellabond) copings, the mean vertical discrepancy was 41.062. All dimensional related assessments were completed accurately by stereo microscope in micron. For group III (Bellabond), measured P value was significant (0.02). **Conclusion:** Within the limitations of the study, authors concluded that the vertical marginal discrepancy at the margin of the casting and the die was minimum for Star Loy N and maximum for Mealloy. Therefore, Star Loy N was the most suitable alloy for maintaining marginal health and preventing bacterial encroachments. Inferences of this study do not recommend the same for all ceramic restorations and other finish line configurations.
Key words: Mealloy, Star Loy N, Bellabond, Dental casting, Marginal Fit

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INTRODUCTION

As we all are aware that the ultimate survival of fixed Prosthodontics solely depends on the condition of the marginal adaptation. Marginal gaps can generate a positive condition for biofilm deposition, thereby contributing to the development of caries and periodontal infection. Metal ceramic are still the most extensively used substance for fabricating complete coverage crowns and fixed partial dentures.[1,2] It is also considered as the standard cure in dentistry. The conventional method for manufacturing the metal substructure is the lost-wax technique and using different metal alloys for casting. The manufacturing of the wax pattern is the most significant and lab dependent step in building the porcelain fused to metal crown. In this time consuming job, the wax pattern's quality is dependent on the expertise of the individual. An excellent marginal fit seems to be one

of the most imperative methodological factors for the long term success of metal-ceramic crowns. Many of the researches have shown that higher marginal gaps usually expose the luting cement material to the oral environment. Therefore, this eventually leads to cement dissolution and development of secondary caries.[3,4] The cement seal becomes feeble, permits the encroachment of bacteria, and can produce inflammation of the vital pulp. Several studies in the literature have illustrated that huge marginal discrepancy in a fixed restoration ends up with a higher plaque index and lowered periodontal health. Minimal marginal gaps results in less gingival irritation cement dissolution, recurrent caries and marginal discoloration.[5,6] Various studies in the literature have demonstrated that an extremely thick cement layer may cause residual stresses on the tensile surface as a result of the deformation of the cement material under cyclic loading.[7,8] These increased tensile stresses may damage the porcelain and initiate chipping of the porcelain layer. Keeping all these significant factors in the mind, authors have planned to evaluate the marginal accuracy of metal margins fabricated with three commonly used alloys using stereomicroscope. To assess the marginal accuracy of metal margins fabricated with three commonly used alloys in the field of Prosthodontics. Marginal assessments were accomplished by using stereomicroscope.

MATERIALS AND METHOD

This study was designed, planned and conducted in the department of prosthodontics of the institute. Three commonly practiced pfm alloys were studied in this study. They were Mealloy, Star Loy N, Bellabond. To perform this study, total thirty metal coping samples were fabricated and divided into three study groups of ten each. All thirty metal copings were made by wax patterns produced by a custom made metal die. The customized die was prepared similar to the shape and dimension of mandibular first molar preparation. The height of the tooth preparation portion of metal die was maintained constant at 5 mm. This was fixed vertical dimension at desired line angles. All metal copings were made by routine investment and casting methods. Parts of custom made metal die were assembled for wax pattern fabrication. The master die was kept as a control. While customizing the metal die, we have ensured to keep the diameter of the die constant at 11 mm. Shoulder finish line was generated near finish line and kept constant ubiquitously 1.2 mm wide. A directional notch was also made on any one surface of the tooth preparation section of the die in the region of finish line. This directional notch was a metal ditch of square shape of 1.5 mm with 1mm depth. This unique designing also helped in the smooth and single path insertion of metal copings during measurements under microscope. Die lubricant was applied to the Metal Die and the molten blue Inlay wax was injected into molten form into the channel of die. This was assisted by 2 ml disposable syringes with controlled piston pressure exerted by single operator. The injection channel in the die serves as sprue therefore; this sprue was attached by itself at the centre of all wax patterns. This wax sprue was consequently intentionally attached for easy removal of wax pattern from master metal die. Phosphate- bonded Investment material was used as per manufacturer's recommendations. Each coping was invested independently in one metal ring. Burnout furnace was used for burnout of the wax pattern using software loaded preheating technique. The investment was kept in the furnace at room temperature and was heated continuously until 925°C at the rate of 9°C/min. Divesting and finishing was also done by standard methods. Castings with any casting defects were rejected and repeated. The dimensional assessments were done with Stereomicroscope [Labomed-Zoomar] at typical magnification. The measurement was completed on total of surfaces per tooth. The mean of all surface were calculated as the final reading for that sample. Mean gap value of the four tested metal surfaces were considered final for that sample.

STATISTICAL ANALYSIS & RESULTS

All resultant data was accumulated and complied in the MS excel sheet to make final spread sheet. This was further forwarded for suitable statistical analysis using SPSS latest package 21.0. Data was shown in mean with Standard Deviation if any. P value less 0.05 was considered as significant one. Table 1 and graph I shows basic statistical evaluation of marginal discrepancies at all four surfaces (group I). Here, group I (Mealloy) samples were studied in details by statistical tests. The mean vertical discrepancy was 58.053. This was anticipated by calculating the mean values of all the surfaces (buccal, lingual, mesial, and distal). All visual data compilation was completed precisely by stereo microscope. All measurements were attempted in microns. P value was non significant (0.09). Table 2 and graph 2 shows basic statistical evaluation of marginal discrepancies at all four surfaces (group II). Here, group II (Star Loy N) samples were studied in details by statistical tests. The mean vertical discrepancy was 32.160. This was projected by calculating the mean values of all the surfaces (buccal, lingual, mesial, and distal). All visual data compilation was completed precisely by stereo microscope. All measurements were attempted in microns. P value was non significant (0.06). Table 3 and graph 3 shows basic statistical evaluation of marginal discrepancies at all four surfaces (group III). Here, group III (Bellabond) samples were studied in details by statistical tests. The mean vertical discrepancy was 41.062. This was projected by calculating the mean values of all the surfaces (buccal, lingual, mesial, and distal). All visual data compilation was completed precisely by stereo microscope. All measurements were attempted in microns. P value was significant (0.02).

Graph 1: MEAN, STANDARD DEVIATION, 95% COEFFICIENT INTERVAL FOR ALL SURFACES OF SAMPLES OF GROUP I

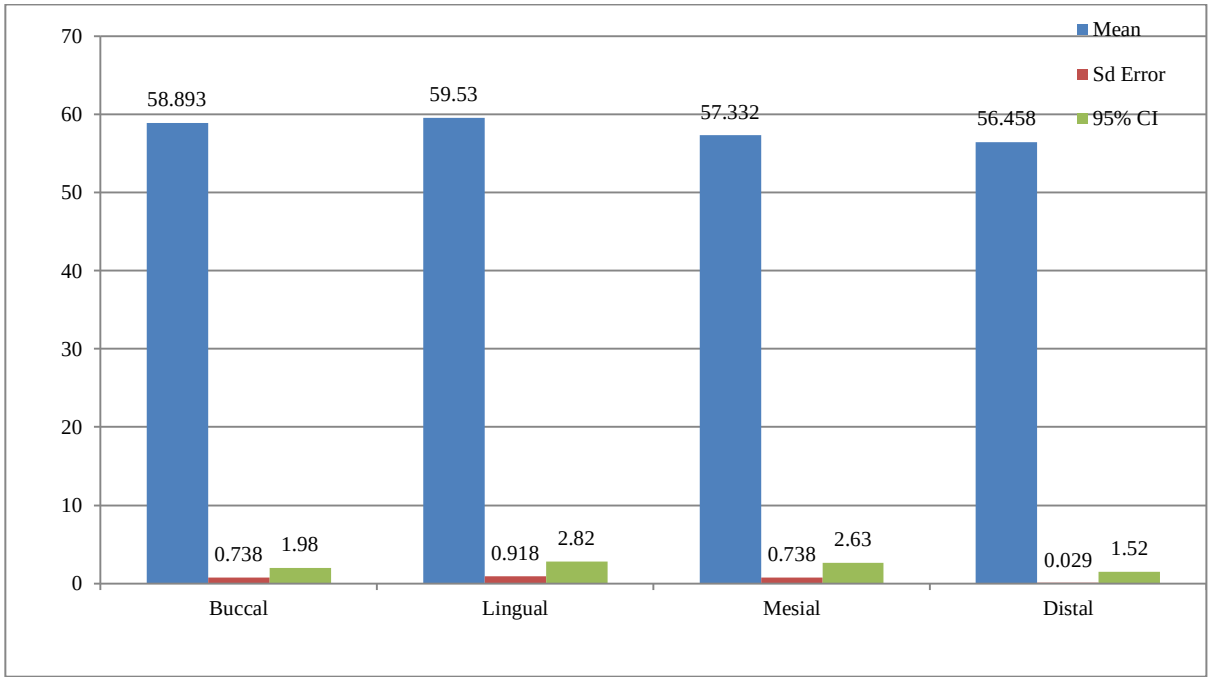

Table 1: BASIC STATISTICAL EVALUATION OF MARGINAL DISCREPANCIES AT ALL FOUR SURCACES (GROUP I)

Groups	Surfaces	Mean	SD	Sd Error	Mean Average	95% CI	df	P value
Group I (Mealloy) n=10	Buccal	58.893	1.6	0.738	58.053	1.98	1.0	0.09
	Lingual	59.530	1.9	0.918		2.82	2.0	
	Mesial	57.332	2.1	0.738		2.63	1.0	
	Distal	56.458	1.8	0.029		1.52	2.0	

***p<0.05 significant**

Graph 2: MEAN, STANDARD DEVIATION, 95% COEFFICIENT INTERVAL FOR ALL SURFACES OF SAMPLES OF GROUP II

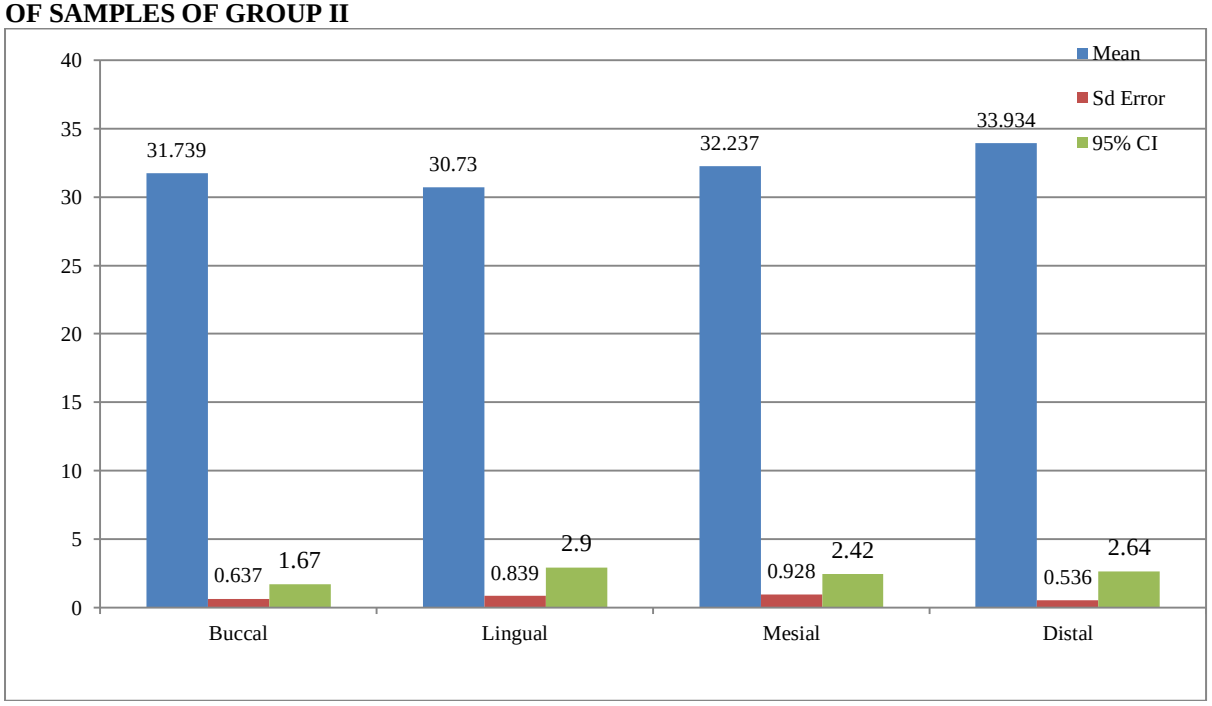

Table 2: BASIC STATISTICAL EVALUATION OF MARGINAL DISCREPANCIES AT ALL FOUR SURFACES (GROUP II)

Groups	Surfaces	Mean	SD	Sd Error	Mean Average	95% CI	df	P value
Group II (Star Loy N) n=10	Buccal	31.739	1.2	0.637	32.160	1.67	1.0	0.06
	Lingual	30.730	1.9	0.839		2.90	2.0	
	Mesial	32.237	1.2	0.928		2.42	1.0	
	Distal	33.934	2.9	0.536		2.64	2.0	

***p<0.05 significant**

Graph 3: MEAN, STANDARD DEVIATION, 95% COEFFICIENT INTERVAL FOR ALL SURFACES OF SAMPLES OF GROUP III

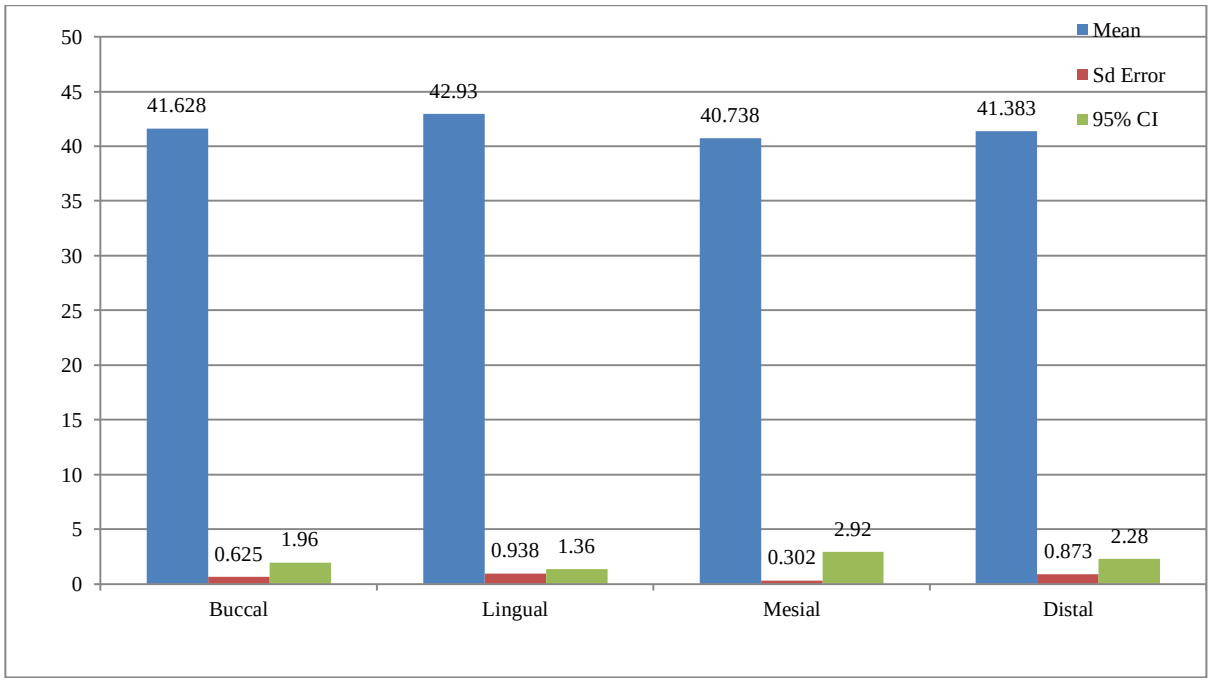

Table 3: BASIC STATISTICAL EVALUATION OF MARGINAL DISCREPANCIES AT ALL FOUR SURCACES (GROUP III)

Groups	Surfaces	Mean	SD	Sd Error	Mean Average	95% CI	df	P value
Group III (Bellabond) n=10	Buccal	41.628	1.1	0.625	41.062	1.96	2.0	0.02*
	Lingual	42.930	1.3	0.938		1.36	1.0	
	Mesial	40.738	1.9	0.302		2.92	1.0	
	Distal	41.383	2.2	0.873		2.28	2.0	

***p<0.05 significant**

DISCUSSION

Literature has well evidenced that the metal ceramics are still the most widely used material for fabricating complete-coverage crowns and fixed partial dentures. The conventional method for making the metal substructure is the lost wax casting process of noble metal alloys.[9,10] Esthetic dilemmas with metal ceramics can be attributed to the metal coping, which affects the transparency of the crown by reducing the transmission of light and by increasing its reflective capability. Many of the researchers have a general agreement that restorations must have margins as close as possible to the abutment to guarantee their long term success.[11,12] Numerous researches in the past have evidenced that conventional cast noble metal ceramic crowns have marginal fit values that are considered to be within the limits of scientific acceptability. Marginal fit of fixed dental prostheses is determined by the size of the gap between the margin of the restoration and finish line of the prepared tooth.[13,14] The most imperative factors affecting marginal and internal fit of fixed dental prostheses are the material used, the type of finish line as well as various methods of restoration manufacture. Poor internal adaptation can lead to a lack of restoration retention and poor resistance form for the tooth-restoration complex. Besides, thick cement layer favors a higher concentration that can lead to micro cracks, piece maladjustment and even to marginal fractures of loose ceramic.[15,16] Because of the higher marginal inconsistency the cement makes up a thicker layer which undergoes more influence of the oral

cavity environment resulting in cement dissolution which in its turn leads to accumulation of the tooth biofilm, hypersensitivity, marginal discoloration, microleakage, caries, more gingival sulcular fluid flow, pulp infection and eventual bone loss and lesion of periodontium. Marginal fit is clinically evaluated by probing.[17] Marginal fit can be indirectly assessed radiographically, and through epoxy resin replicas by light and scanning electron microscopy. Despite their wide use, routine microscopes might result in inaccurate measurement, poor identification of reference points, projection errors and rounding of the margins.

CONCLUSION

Marginal fit of the casting is the factor which can lead to development of secondary dental caries, adverse pulpal responses and periodontal contamination. Within the limitations of the study, authors concluded that the vertical marginal discrepancy at the margin of the casting and the die was minimum for Star Loy N and maximum for Mealloy. Therefore, Star Loy N was the most suitable alloy for maintaining marginal health and preventing bacterial encroachments. Inferences of this study do not recommend the same for all ceramic restorations and other finish line configurations. However, we expect some other large scale studies to be conducted that might establish certain standard and concrete guidelines in these perspectives.

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