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Stereomicroscopic Evaluation of the Marginal Accuracies of Metal Margins Fabricated with Three Different Alloys: An In Vitro Study

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ABSTRACT

Background: To evaluate the marginal accuracy of metal margins fabricated with three commonly used alloys using a stereomicroscope.

Materials and Methods: Samples were made in three metal groups of fifteen each. Total of forty-five metal copings was fabricated on a prefabricated metal die. We utilized three commercially available alloys, i.e., Mealloy, Star Loy N, Supranium. Metal copings were fabricated by standard casting procedures. The brass master die made similar to the shape and dimension of mandibular first molar preparation. The tooth preparation section of the metal die was made with a vertical dimension of 6 mm from the cavosurface line angle to the occlusoaxial line angle. All wax pattern was separated from the master die by attaching a wax sprue of 3 mm diameter and 6 mm length at the centre of the occlusal surface. Investment of wax patterns was completed by phosphate-bonded investment material. The measurement of fit of the metal copings was recorded by stereo photomicroscope at four different surfaces. Samples were placed steadily at the testing platform of the microscope for gap evaluation and quantification. Mean of the four measured surfaces were taken as final for that particular sample. Samples with any kind for casting defects were discarded, and the procedure was repeated for that sample.

Results: All the recorded data and responses were compiled 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 the group, I (Mealloy) samples, the mean vertical gap was 55.322. For group II (Star Loy N) samples, the mean vertical gap was 35.659. For group III (Supranium) samples, the mean vertical gap was 46.062. All measurements were attempted by using a stereomicroscope in micron. For group III (Supranium), the P-value was significant (0.01).

Conclusion: Within the limitations of the study design, it can be concluded that the vertical marginal gap at the margin of the casting and the die was minimum for Star Loy N and maximum for Mealloy.

Keywords: Mealloy, Star Loy N, Supranium, dental casting techniques, marginal accuracy.

INTRODUCTION

As we all know that the ultimate success of all dental restoration depends upon the marginal adaptation of casting to the basic tooth structure. The use of base metal alloys for fixed restorations has increased dramatically since their introduction in the 1960s.[1,2] The sole accurateness of the marginal fit of restoration is crucial for its durability and vigorous periodontium. Accurate marginal

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adaptation is required to attain better mechanical, biological and esthetic prognosis.[3,4] The marginal inconsistencies of cast restorations are predictable in spite of careful attention being given to clinical and laboratory processes. The literature has well evidenced that clinically adequate marginal inconsistency for cast restorations ranges from 15 to 170 μm.[5,6] Therefore, most of the pioneer researchers have stated that the final success of any dental cast restoration depends upon the marginal fit. It is a well-established fact that all perfectly fitting cast restoration is necessary for prosthetic success. It is because of diminished plaque accumulation at the finish lines.[7,8,9] This is how it offers enhanced mechanical properties, less cement space (fewer possibilities for leakage), and enhanced aesthetics. Many of the studies in the literature have shown that the marginal adaptation of castings fundamentally depends on careful tooth preparation, precise impressions, precision castings with cautious finishing, and cementation processes. Many of the Meta-analysis also depict Ni–Cr alloys as the metal of choice for castings in place of the gold alloys.[10,11] Additionally, an economic aspect also plays a huge role in the development of non-precious alloys for removable frameworks. This is the basic reason why the cobalt and nickel base alloys became the alloys of choice for partial dentures. Keeping all these critical factors in the mind, authors have genuinely attempted to evaluate the marginal accuracy of metal margins fabricated with three commonly used alloys using a stereomicroscope.

MATERIALS AND METHOD

This study was designed, outlined and executed in the department of prosthodontics of the institute. Porcelain fused to metal alloys used in this study was Mealloy, Star Loy N, Supranium for the fabrication of metal coping. To conduct this study, samples were made in three metal groups of fifteen each. Total of forty-five metal copings was fabricated on a prefabricated brass metal die.

Group I: Mealloy (n=15)
Group II: Star Loy N (n=15)
Group III: Supranium (n=15)

The brass master dies made similar to the shape and dimension of mandibular first molar preparation. We used this brass master as a control. The tooth preparation section of metal die was made with a vertical dimension of 6 mm from the cavosurface line angle to the occlusoaxial line angle. We have ensured to keep the diameter of the die at the cavosurface line angle as 12 mm. Finish line width of shoulder width was kept constant everywhere 1.1 mm wide with smoothed axial-occlusal angles. A "V" shaped direction notch was made on one surface of the tooth preparation section of the die in the region of finish line. This was to ensure the exact positioning of the metal copings during measurements under the microscope. Die lubricant (Isocera, Bego) was applied to the Metal Die, and the molten Inlay wax (Bego, Germany) was put in an electrically controlled wax bath (Bego) and kept at the recommended temperature of 160°F. The molten inlay wax was injected in the desired spaces. All wax pattern were separated from the master die by attaching a wax sprue of 3 mm diameter and 6 mm length at the center of occlusal surface. Investment of wax patterns was completed using a silicone ring of 3 cm diameter using Bellasun T phosphate- bonded investment material (Bego, Germany) according to the manufacturer's recommendations. Each coping was invested individually in one ring each immediately after its fabrication. Burnout of the wax pattern was done using a programed preheating technique. The investment was kept in the furnace at room temperature and was heated continuously until 950°C at the rate of 8°C/min. Castings having more than one internal nodule were rejected. Each coping was seated on the metal die. The measurement was attempted with the help of Stereomicroscope [Labomed-Zoomar] at standard magnification. The measurement was completed on a total of surfaces per tooth. The data were captured and transformed into the computer. Marginal gaps were measured to the nearest micron on each cast coping. The mean of all surface was calculated as the final reading for that sample.

RESULTS

Results and presumptions were arranged sensibly and sent to appropriate statistical analysis/tests using SPSS latest package 21.0. Data was illustrated in mean with Standard Deviation if any. P-value less 0.05 was considered as a significant one. Table 1 and graph I show a mean vertical gap at the margin of the casting and the die in micron. Here, group I

(Mealloy) samples were evaluated. The mean vertical gap was 55.322. This was estimated by calculating the mean values of all the surfaces (buccal, lingual, mesial, and distal). All measurements were attempted by using a stereomicroscope in micron. P-value was non-significant (0.08). Table 2 show that mean vertical gap at the margin of the casting and the die in micron. Here, group II (Star Loy N) samples were evaluated. The mean vertical gap was 35.659. This was estimated by calculating the mean values of all the surfaces (buccal, lingual, mesial, and distal). All measurements were attempted by using a stereomicroscope in micron. P-value was non-significant (0.09). Table 3 show that mean vertical gap at the margin of the casting and the die in micron. Here, group III (Supranium) samples were evaluated. The mean vertical gap was 46.062. This was estimated by calculating the mean values of all the surfaces (buccal, lingual, mesial, and distal). All measurements were attempted by using a stereomicroscope in micron. P-value was significant (0.01).

Graph 1: Mean, standard error, 95% coefficient interval for all surfaces of samples of group I

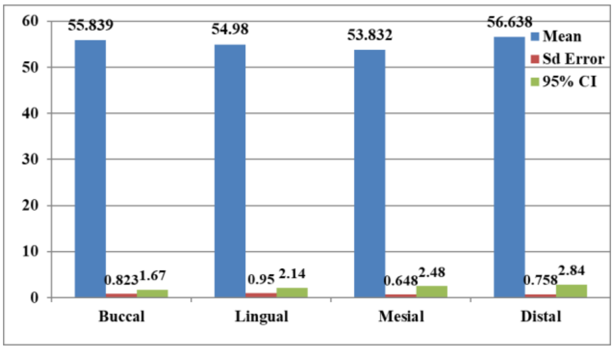

Table 1: Vertical marginal gap at the margin of the casting and the die in micron (GROUP I)

Groups	Surfaces	Mean	SD	Sd Error	Mean Average	95% CI	df	P-value
Group I (Mealloy) n=15	Buccal	55.839	2.2	0.823	55.322	1.67	1.0	0.08
	Lingual	54.980	1.6	0.950		2.14	2.0	
	Mesial	53.832	2.4	0.648		2.48	1.0	
	Distal	56.638	2.1	0.758		2.84	2.0	

***p<0.05 significant**

Table 2: Vertical marginal gap at the margin of the casting and the die in micron (GROUP II).

Groups	Surfaces	Mean	SD	Sd Error	Mean Average	95% CI	df	P-value
Group II (Star Loy N) n=15	Buccal	35.459	1.2	0.738	35.659	1.67	1.0	0.09
	Lingual	34.783	1.7	0.910		2.23	2.0	
	Mesial	34.832	1.4	0.566		2.32	1.0	
	Distal	37.564	2.1	0.758		2.84	2.0	

***p<0.05 significant**

Table 3: Vertical marginal gap at the margin of the casting and the die in micron (GROUP III).

Groups	Surfaces	Mean	SD	Sd Error	Mean Average	95% CI	df	P-value
Group III (Supranium) n=15	Buccal	46.738	1.2	0.745	46.062	1.67	1.0	0.01*
	Lingual	47.713	1.8	0.418		1.23	1.0	
	Mesial	46.238	1.2	0.132		2.34	1.0	
	Distal	43.562	2.1	0.849		2.44	2.0	

***p<0.05 significant**

DISCUSSION

Literature has well evidenced that dental casting is one of the most extensively used methods for the production of an indirect dental restoration. The metal margin of the cast restorations has been very extensively worked out in the literature. Initially, studies had been focused only on the usages of light microscopy whoever, stereomicroscope is being utilized to draw more refined results.[12,13,14] Preservation of the periodontium is one of the basic principles of the preparation of the tooth. This can be managed optimally by making the finish line or margin region healthy. Most of the crown related failures are usually due to issues related to marginal gaps like secondary caries and micro-leakage. The ultimate capability to produce accurate castings and reproduce them repetitively has been the key objective of many researchers. Ill-fitting marginal adaptation of crown and bridge usually end-up with numerous harmful consequences like secondary caries, staining, and periodontal collapse.[15,16] The precision of fit of casting is indispensable for durability, and clinical success of the cast restoration attempted in the mouth. The accurateness of casting is liable to change by material related volumetric changes are happening because of the contraction of wax and alloys. Such contraction can be adjusted by setting expansion, hygroscopic expansion or thermal expansion of the investment. The definitive estimation of the cast restoration depends on the correctness of the casting and repetition of the tooth anatomy. The ultimate fit of the casting is the result of a restricted expansion of the mould, which is the collective result of factors such as the composition of the investment material, water-powder ratio, mixing method, temperature of the room and liquid, and type of the liner.[17,18,19] The production of a satisfactory wax pattern and the type of the wax pattern material used is an imperative parameter that will affect the marginal fit during the casting process. In the recent past, the marginal fit has been recognized as one of the significant causes for failure of cast restorations. The construction of cast restorations usually involves various technique sensitive steps to obtain restorations with an accurate fit. The increased recognition of porcelain fused to metal restorations is because of ever-increasing esthetic demands, improvement in casting techniques and alloys along with wide application in all clinical situations including even complex restorative needs. Tooth preparation for fixed prosthesis must respect the strict biomechanical norms involving the biological, mechanical and esthetic factors for finest success. Also, as and when we select another alloy for a cast restoration, one of the numerous significant factors to be considered is the dimensional accurateness of resultant casting. The casting must fit exactly to the prepared tooth, with an optimal marginal fit.[20,21,22]

CONCLUSION

Deficient margins can end up in intraoral deprivation of cement which could further show loss of marginal seal. Marginal fit of the casting is one factor that can lead directly or indirectly to the development of secondary dental caries, pulpal reaction and periodontal infection. Within the limitations of the study design, it can be concluded that the vertical marginal gap at the margin of the casting and the die was minimum for Star Loy N and maximum for Mealloy. Our study results should be considered as suggestive for presuming prognosis for similar clinical conditions. However, we anticipate some other large-scale studies to be performed that might further establish a certain standard and genuine guidelines in these outlooks.

CONFLICTS OF INTEREST

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

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