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ORIGINAL ARTICLE

A Comparitive Evaluation of the Marginal Adaptation of Zirconium Coping and Nickel–Chromium Coping Using Shoulder Finish Line Design: An Invitro Study

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Abstract Marginal adaptation is an important factor for long term clinical success of the restoration. This study aims to evaluate and compare the marginal adaptation of zirconium coping and nickel–chromium coping using the shoulder finish line design. For the purpose of this study 30 master dies were fabricated. A total of 30 copings were fabricated in which 15 zirconia copings and 15 Ni–Cr copings were fabricated. The copings obtained were seated on the die and marginal discrepancy between the metal die and the copings were then measured with Scanning electron microscope at magnification of ×50 and the findings were statistically analyzed. Mean and standard deviation values of marginal discrepancy of cervical margins of zirconia copings were 39.32 and 2.66 μm and Ni–Cr copings were 129.98 and 2.57 μm. Higher mean marginal gap (μm) is recorded in Ni–Cr copings compared to zirconia copings. The difference in mean marginal gap (μm) between the two copings is found to be statistically significant ($P < 0.001$). Within the limitation of this study it was concluded that higher mean marginal gap (μm) was recorded in Ni–Cr copings compared to zirconia copings. The difference in mean marginal gap (μm) between the two copings is found to be statistically significant ($P < 0.001$).

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Introduction

Marginal adaptation, the junction between a cemented restoration and the tooth is always a potential site for recurrent caries because of dissolution of the luting agent and inherent roughness. The more accurately the restoration is adapted to the tooth the lesser the chance of recurrent caries or periodontal disease. Rough, irregular junctions greatly increase the length of the margin and substantially reduce the adaptation of the restoration. The importance of preparing smooth margins cannot be over-emphasized. The time spent obtaining a smooth margin will make the subsequent steps of tissue displacement, impression making, die formation, waxing and polishing much easier and will ultimately provide the patient with a longer lasting restoration [1, 2].

Nickel–chromium alloys were preferred due to its wide range of physical and mechanical properties. They have higher yield strength and modulus of elasticity, greater percentage of elongation which makes it more adaptable, greater hardness and resistance to sag formation, low specific gravity and high porcelain to metal bond strength [3].

Over the last two decades interest in more esthetically pleasing and metal free restoration has increased the demand for all ceramic restorations, and several systems are currently available that employ sophisticated CAD/CAM technology.

Retention and marginal discrepancy are crucial factor affecting the longevity of complete crowns. Preparation design luting cement and cementation technique can significantly affect retention and marginal seating. Factors influencing crown retention have been related to preparation design. The geometric configuration, convergence

angle, surface area and surface roughness have been found to affect retention [4].

This study aims to evaluate and compare the marginal adaptation of zirconium coping and Ni–Cr coping using the shoulder finish line design.

The objective of this study is to determine which materials have better adaptation and clinical application of the results.

Material and Methodology

To assess and compare the accuracy of zirconia copings and Ni–Cr copings. A total of 30 copings were fabricated, 15 zirconium copings were fabricated using CAD/CAM technology, and the remaining 15 Ni–Cr copings were fabricated using lost wax technique.

Thirty dies were machined in steel to simulate a tooth preparation for a complete metal-ceramic crown of a maxillary central incisor. Each die was 8.0 mm in height, 7.0 mm in cervical diameter, and had a total convergence of 6 °. The finish line of 1 mm in width having 90 ° shoulder finish line. To eliminate any variation, 30 master dies were milled from the block of steel to produce standardized dies. To standardize the technique further, all 30 dies were duplicated using vinyl poly siloxane putty impression material\relined with vinyl polysiloxane light viscosity material to record all fine details. Later the impressions were poured in type IV dental stone. 30 copings were directly fabricated on these dies.

Zirconia copings are fabricated using CAD/CAM system (Cercon, Degudent). The cercon unit consist of scanning unit which scans dies then transfer the information to Cercon art where by using Cercon software copings are designed i.e. die spacer covering 80 % of the die, thickness of cement space was 30 μm, which is kept 1 mm short of margin. Thickness of coping is 0.5 mm, which is uniform all around. Cercon consists of a milling unit which mills zirconium oxide blanks into required dimensions. The sintering was done in a sintering unit provided by the manufacturer. The specimens were sintered for 6.5 hours where the temperature of the unit goes up to 1,350 °C.

The copings are examined for deformity. All copings were placed on their corresponding master dies.

Fabrication of Ni–Cr coping using lost wax technique. To standardize the technique all 15 Ni–Cr copings are fabricated by using lost wax technique i.e. fabrication of wax pattern, spruing, investing, casting, sandblasting and measurements were carried out by the same operator to minimize the operator's variability.

Measurement of Marginal Discrepancy

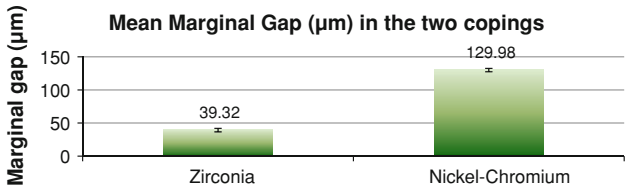
Each coping is seated on the die and subjected to constant load of 400 g for 5 min. The marginal discrepancy between the metal die and the copings are then measured with scanning electron microscope at magnification of ×50. The measurements were made at four quadrants mid buccal, mid mesial, mid lingual, mid distal between cervical margin of the casting and the finish line of the die. The images were captured and later transformed to the computer. Measurements were done with the help of the **Image J** software.

Result

The marginal gap of zirconia coping and Ni–Cr copings (in microns) are shown in Table 1. The measurements were made at four quadrants mid buccal, mid distal, mid lingual, and mid mesial.

Table 1 Marginal gap (μm) recorded at different sides in the two copings

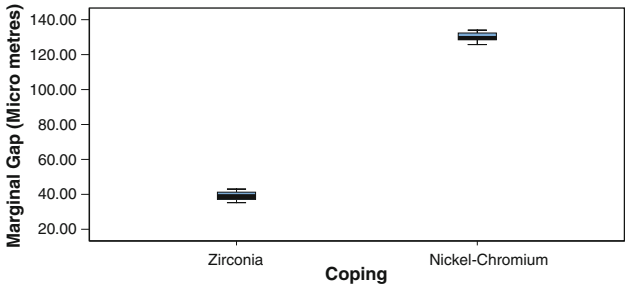
Coping	Side	n	Mean	SD	Min	Median	Max
Nickel–chromium	Buccal	15	130.07	2.63	125	130	135
	Distal	15	129.73	3.01	124	130	135
	Lingual	15	130.33	3.13	126	130	135
	Mesial	15	129.80	2.24	125	130	132
Zirconia	Buccal	15	39.07	2.69	35	39	43
	Distal	15	39.40	2.59	35	40	43
	Lingual	15	39.40	2.97	35	40	43
	Mesial	15	39.40	2.92	35	39	44



Graph 1 Mean marginal gap (µm) in the two copings

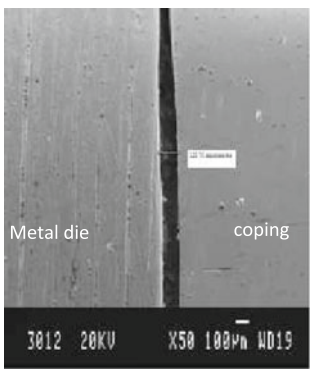
The mean marginal gap of zirconia copings and Ni–Cr copings are shown in Graph 1.

The comparison of mean marginal gap zirconia copings and Ni–Cr copings are shown in Table 2 and box plot.

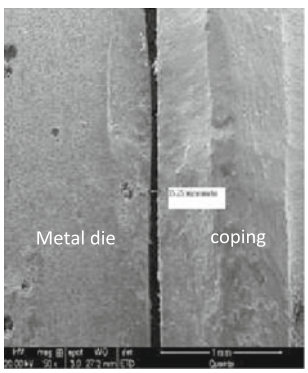


Higher mean marginal gap (µm) is recorded in Ni–Cr copings compared to zirconia copings. The difference in mean marginal gap (µm) between the two copings is found to be statistically significant ($P < 0.001$).

In the present study zirconia copings fabricated using CAD/CAM showed better marginal adaptation than Ni–Cr coping fabricated using lost wax technique. The marginal discrepancy in micrometer is less in zirconia copings when compared to Ni–Cr copings (39.32 vs. 129.98) with $t = -94.85$; $P = 0.001$. Thus, the result of the study indicates that zirconia coping fabricated using CAD/CAM technology has better marginal adaptation than Ni–Cr coping.



SEM image of Zirconia coping



SEM image of Ni-Cr coping

Table 2 Comparison of mean marginal gap between the two copings

Coping	n	Mean	SD	Mean difference	t	*P* Value
Zirconia	15	39.32	2.66	−90.667	−94.854	<0.001*
Nickel–chromium	15	129.98	2.57			

*Denotes significant difference

Discussion

Marginal adaptation plays a vital role in the longevity of the periodontal health. Marginal gap is one of the clinically important measurements for the accurate adaptation of the restoration. One of the factors that dictate success of fixed restoration is the close adaptation at the margins. Lack of adequate adaptation is potentially detrimental to both tooth and supporting periodontal tissues [5].

Homes et al. [6] described marginal fit as the distance from the internal surface of the coping to the axial wall of the preparation at the margin measured at various points between the coping and the tooth. Marginal discrepancy is defined as the angular combination of marginal gap and any extension error or perhaps more simply described as the distance from the margin of a coping to cavo-surface angle of a tooth preparation [7].

A cast coping is considered satisfactory when it achieves suitable anatomical form, correct polishing, good cervical and internal adaptation. In an attempt to improve the casting procedure, a wide range of materials and techniques have been reported in an effort to achieve better results. Ni–Cr alloys have a wide range of physical and mechanical properties. Properties of Ni–Cr alloys include greater hardness, greater resistance to sag formation, lower specific gravity and high porcelain to metal bond strength [8, 9].

Advances in dental ceramic materials and processing techniques have helped in increasing the strength and improving the fit of ceramic restorations. Among them, CAD/CAM technology has facilitated the development and application of superior dental ceramics. During the last two decades, exciting new developments have led to the success of contemporary dental CAD/CAM technology. Another important factor has been the development of aluminum oxide and zirconia oxide ceramic materials, which possess excellent machinability and physical strength [8]. Zirconia though has been available for use in restorative dentistry for several years, there has been an increased interest recently in these materials. Zirconia based restorations are quite versatile and can be used for crowns, bridges, and implant abutments. The type of zirconia used in dentistry is yttria tetragonal zirconia polycrystal material, which is a zirconia oxide. The flexural

strength of zirconia oxide materials has been reported to be in the range of 900–1,100 MPa [10].

In the present study Group A (zirconia coping fabricated using CAD/CAM) showed better marginal adaptation than Group B (Ni–Cr coping fabricated using lost wax technique). The marginal adaptation in micrometer is less in Group A when compared to Group B (39.32 vs. 129.98) with $t = -94.85$; $P = 0.001$. Thus, the result of the study indicates that zirconia coping fabricated using CAD/CAM technology has better marginal adaptation than Ni–Cr coping.

Limitation of the Present Study

The present study is an in vitro study and has some limitations; the first would be limited sample size and method of evaluation of marginal adaptation. Present study specimen were checked for marginal adaptation at four sites but not all along the margin. Present study the testing is carried out on the metal die which does not represent the intra-oral condition in which teeth undergo: cyclic loading at varying velocities and magnitudes, subjected to chemical and thermal changes while being immersed in a wet environment. Though CAD/CAM systems are accurate the present study was restricted to Cercon system. Hence larger sample sizes of all CAD/CAM systems are required as different systems uses different technologies.

Clinical Implications

Zirconia copings can be recommended for restoring anterior and posterior teeth. Aesthetically zirconia has superior properties over Ni–Cr coping; hence it is recommended for anterior teeth. Ni–Cr coping can be recommended for restoring posterior teeth where aesthetics and cost is not the prime concern. However the cost factor can be overcome in the near future.

Conclusion

Within the limitation of this study the following conclusion were drawn.

Higher mean marginal gap (μm) was recorded in Ni–Cr copings compared to zirconia copings. The difference in mean marginal gap (μm) between the two copings is found to be statistically significant ($P < 0.001$).

The copings produced using lost wax technique showed larger gaps at the margin when viewed using SEM. The zirconia copings produced using CAD/CAM technology showed smaller gaps at the margins when viewed using SEM. Thus this study proved that the marginal adaptation of coping was improved on using CAD/CAM technology.

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