Marginal Gap Discrepancies in Metal Porcelain Crowns with Co-Cr Coping before and after Porcelain Firing

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Abstract
Metal porcelain crown is still commonly used because of the strength of the metal and the esthetic of the porcelain. Base metal alloys that commonly used as copings of metal porcelain crowns are nickel-chromium and cobalt-chromium. Cobalt-chromium is preferable because it has better biocompatibility for patients that have allergies to nickel. The marginal gap is one of the important factors that determine the success of a restoration. This study aims to measure the marginal gap between the cervical margin of the prepared tooth and the cervical margin of a metal porcelain crown with Co-Cr coping before and after porcelain firing. Sixteen teeth that needed to be treated with metal porcelain crowns were examined at the Dental Teaching Hospital Faculty of Dentistry, Universitas Indonesia, by using a consecutive sampling method. The marginal gaps of metal porcelain crowns with Co-Cr coping before and after porcelain firing were measured with the impression replica technique at four surfaces (buccal, mesial, distal, and palatal) using an optic microscope (Olympus BX41. Statistical analyses revealed a significant difference between the marginal gaps of metal porcelain crowns before and after porcelain firing on all surfaces ($p<0.05$), which was clinically acceptable.

Clinical article (J Int Dent Med Res 2017; 10(Special Issue): pp. 715-718)
Keywords: Marginal gap, cobalt-chromium, metal porcelain crown.
Received date: 17 August 2017 **Accept date:** 19 September 2017

Introduction

Metal porcelain crowns are still commonly used because of the strength of the metal coping and the esthetic aspect of porcelain. The alloys that are used as *copings* of metal porcelain crowns are *high noble, noble,* and *predominately base*. The base metal alloys that are commonly used are nickel-chromium and cobalt-chromium. Cobalt-chromium is preferable because it has better biocompatibility for patients with allergies to nickel and has a more affordable cost than gold restorations.[1]

The success of a prosthetic restoration depends on three factors: biological, mechanical, and esthetic. One of the most important aspects of the biological factors is the marginal gap. Marginal gaps cause cement dissolution and plaque accumulation that lead to secondary caries, periodontal inflammation, and loss of the restoration.[2–8]

Some of the factors affecting the marginal gap include the alloy type and the shrinkage after porcelain firing caused by the difference in the thermal coefficient between the metal coping and porcelain. This shrinkage can cause a previously precise and fit metal coping to become imprecise after porcelain firing.[4,9,10]

The clinically acceptable marginal gap varies according to the available literature, but 120µm is usually cited as the maximum.[2,4,7,8,11–13]

This study aims to measure and compare the marginal gap of metal porcelain crowns with cobalt-chromium coping before and after porcelain firing, which is done clinically by creating a three-dimensional replica of space between the tooth and the restoration using polivynil siloxane impression materials and in the laboratory by measuring the marginal gap using an optic microscope (Olympus BX41).

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Methods

This study was done by measuring the distance from the tooth margin of the metal porcelain crown with Co-Cr coping before and after porcelain firing. The marginal gap was measured by the length of a line perpendicular from the intaglio of the metal porcelain crown to the cervical margin of the prepared tooth. Sixteen teeth that were treated with metal porcelain crowns from the Dental Teaching Hospital Faculty of Dentistry, Universitas Indonesia, were included as samples as a result of using the consecutive sampling method.

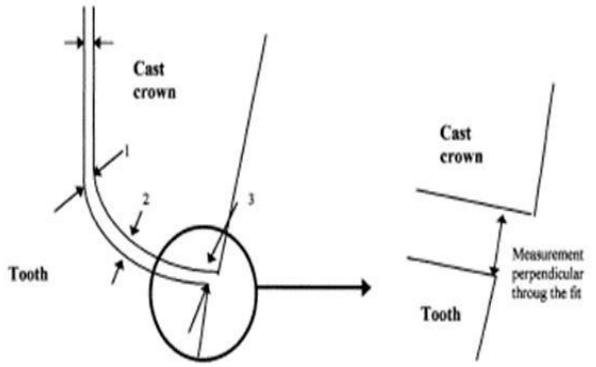

Figure 1. Location of the marginal gap.[14]

Specimens were taken by filling the coping with light-body silicone, the coping was repositioned on the prepared tooth, and then the patient was asked to bite on a cotton roll. Coping with the light-body silicone material was removed from the tooth after the material.[15–18]

A B C

Figure 2. A. Light-body silicone filled to the metal porcelain crown, B. The crown seated over the prepare tooth, C. The silicon replica.

Heavy-body silicone is used to support the light-body silicone.[4,14] After the heavy-body silicone had polymerized, the specimen was removed from the coping and cut into four parts with a cutter along the buccal-lingual direction and mesial-distal direction.

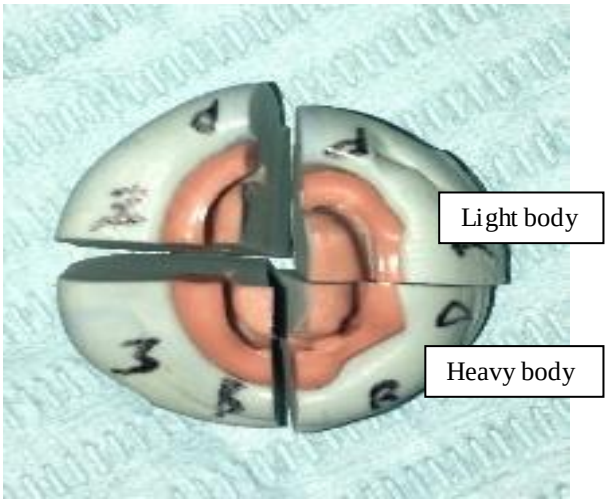

Figure 3. Specimen is removed from the coping and cut into four parts with a cutter along the buccal-lingual direction and mesial-distal direction.

All specimens were prepared and measured by single operator. The thickness of the light body represents the marginal gap, which was then measured using an optic microscope (Olympus BX41). Measurements were taken on four surfaces for each specimen (buccal, lingual, mesial, and distal), and each surface was measured from two parts of the specimens on the same surface. The same method was repeated on the specimens with the metal porcelain crowns after firing. Data processing was done by using a bivariate statistical test to examine the difference between the metal porcelain crown with Co-Cr coping before and after porcelain firing.

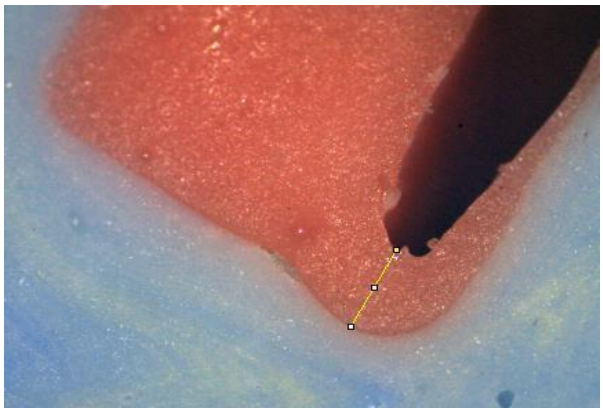

Figure 4. The marginal gap was measured under an optic microscope.

Results

This study analyzed the difference in the marginal gap of metal porcelain crowns with Co-Cr coping before and after porcelain firing. Sixteen teeth were collected and treated twice, before and after porcelain firing. Marginal gap measurements on each of the metal porcelain crowns, before and after porcelain firing, were taken on four surfaces (buccal, distal, mesial, and palatal), with a total of 128 points of measurement that were used in the statistical analysis.

The results of a Shapiro-Wilk normality test showed that the data distribution was not normal. Thus, a non-parametrical Kruskal-Wallis statistical test was used in this study. The marginal gaps on four types of tooth surface did not show a statistically significant difference ($p>0.05$; 0.415) on specimens before porcelain firing and ($p>0.05$; 0.838) after porcelain firing.

The Saphiro-Wilk test was used to examine the normality of data distribution. The result ($p<0.05$) showed that the data distribution was not normal. A non-parametric Wilcoxon test was then used. The result of the Wilcoxon test ($p<0.05$) indicated a statistically significant difference between the marginal gaps of metal porcelain crowns before and after porcelain firing on all the surfaces.

Discussion

The marginal gap is one of the most important aspects that determine the success of a restoration. Marginal discrepancies cause cement dissolution and plaque accumulation that lead to secondary caries, periodontal inflammation, and the loss of the restoration.[2,3,8,19] In this study, the marginal gaps were shown by using the silicone replica technique and were measured under an optic microscope (Olympus BX41).

A statistical analysis of the marginal gaps of metal porcelain crowns on four tooth surfaces showed no significant differences. It can be concluded that the measurements of the marginal gaps of metal porcelain crowns were not affected by the surface being measured.

The statistical analysis showed a statistically significant difference in the marginal gap before and after porcelain firing, but it was still regarded as clinically acceptable. The clinically acceptable marginal gap varies according to the literature, but 120µm is usually cited as the maximum.[2,4,7,8,11–13] In this study, the marginal gaps were still clinically acceptable, except on the mesial surface before porcelain firing (113.5µm; 100−121) and after porcelain firing (118 µm; 105−122) and on the palatal surface after porcelain firing (118µm; 108−121). Several factors affect the marginal gap, such as the alloy type and the shrinkage after porcelain firing caused by the difference in the thermal coefficient between the metal coping and the porcelain.[4,9,10] Residual stress caused by the casting and polishing process on the first firing cycle also leads to a marginal discrepancy.[5,12]

Table 1. Marginal gap of metal porcelain crowns with Co-Cr coping before porcelain firing on four tooth surfaces

	Median (Min-max)	P value
Buccal	112 (105−118)	0.415
Distal	112 (110−117)	
Mesial	113.5 (100−121)	
Palatal	114 (101−119)	

*Kruskal Wallis test, $p>0.05$

Table 2. Marginal gap of metal porcelain crowns with Co-Cr coping after porcelain firing on four tooth surfaces

	Median (Min-max)	P value
Buccal	118 (106−120)	0.838
Distal	117.5 (112−120)	
Mesial	118 (105−122)	
Palatal	118 (108−121)	

*Kruskal Wallis test, $p>0.05$

Table 3. Marginal gap of metal porcelain crowns with Co-Cr coping before and after firing

		Median (Min-Max)			
	N	Buccal	Distal	Mesial	Palatal
Before	16	112 (105−118)	112 (110−117)	113.5 (100−121)	114 (101−119)
After	16	118 (106−120)	117.5 (112−120)	118 (105−122)	118 (108−121)
P value		0.000	0.001	0.000	0.000

*Saphiro-Wilk test, p<0.05

Conclusion

There was a difference was observed between the marginal gaps of metal porcelain crowns with Co-Cr coping before and after porcelain firing. The marginal gaps of metal porcelain crowns on the four tooth surfaces showed no differences.

Acknowledgment

The publication of this manuscript is supported by Universitas Indonesia.

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