Effect of Preparation Depth Differences on the Marginal Fit of Zirconia Crown Copings: An In Vitro Study

Mehdi Sattari Azar, Dr Med Dent[a]/Karl Martin Lehmann, Dr Med Dent[a]/Helmut Dietrich, Dr Med Dent[a]/
Gernot Weibrich, Prof Dr Med Dent[b]/Irene Schmidtmann, MSc[c]/Herbert Scheller, Prof Dr Med Dent[d]

If optical scanning is used for crown fabrication, variability in preparation depth may be a limitation. Therefore, this preliminary laboratory study evaluated marginal fit in relation to preparation depth. Three dies with different preparation depths between the vestibular and oral regions were fabricated. Ten zirconia copings were manufactured for each die, and marginal gaps were examined. Increasing differences in preparation depth influenced the size of the marginal gap between the vestibulo-oral and mesiodistal regions significantly ($P < .001$). This study shows primarily that differences in preparation depth resulted in decreasing marginal precision. *Int J Prosthodont 2011;24:264–266.*

Marginal and internal fit of zirconia frameworks depend on several factors, particularly the characteristics of the underlying preparation, including form and angle.[1] However, until now, no data have been reported regarding preparation depth, and no study has focused on this clinically relevant problem. Thus, this laboratory study evaluated marginal gaps of regions of restorations with different preparation depths. The null hypothesis was that increasing differences in the preparation depth would lead to increased marginal gaps with zirconia crown copings.

[a]*Clinical Instructor, Clinic of Prosthetic Dentistry, University Medical Centre of the Johannes Gutenberg University, Mainz, Germany.*
[b]*Assistant Professor, Clinic of Prosthetic Dentistry, University Medical Centre of the Johannes Gutenberg University, Mainz, Germany.*
[c]*Biostatistician, Institute of Medical Biostatistics, Epidemiology and Informatics, University Medical Centre of the Johannes Gutenberg University, Mainz, Germany.*
[d]*Professor, Clinic of Prosthetic Dentistry, University Medical Centre of the Johannes Gutenberg University, Mainz, Germany.*

Correspondence to: *Dr Mehdi Sattari Azar, Clinic of Prosthetic Dentistry, University Medical Centre of the Johannes Gutenberg University Mainz, Augustusplatz 2, 55131 Mainz, Germany. Fax: +49 6131 17 5517. Email: mehdi.sattariazar@unimedizin-mainz.de*

Drs Azar and Lehmann contributed equally to this article.

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Materials and Methods

Two acrylic teeth were prepared with circumferential chamfer preparations of equal preparation depths. Adjacent molds of each tooth were produced and filled 12 times with an autopolymerizing acrylic resin. The resin dies were cast using the lost wax technique. The cast metal die of a right maxillary canine was referred to as die C0 (Fig 1a), whereas the cast metal die of a left mandibular first premolar was die P0. Then, the acrylic teeth were modified by deepening the preparation lines in the vestibular and oral regions by 1.5 mm to give a metal die of each tooth with the new preparation lines. The resulting die of the right maxillary canine constituted die C1.5 (Fig 1b), and that of the left mandibular first premolar was die P1.5. Next, the preparation lines were deepened by an additional 1.5 mm so that the depth of preparation lines in the vestibular and oral sections were 3.0 mm, and a metal die of each tooth was produced. These dies constituted dies C3.0 and P3.0 (Fig 1c). The dies were scanned with an optical scanner (CEREC inLab, Sirona Dental Systems), and 12 zirconia crown copings were fabricated for each die. The cement space was set at 0 μm. The crown copings were post-sintered using a high-temperature furnace. The marginal gap was measured according to Holmes et al[2] using a light microscope. The preparation line was sectioned into mesial, vestibular, distal, and oral regions. To assess the influence of preparation depth and area on the

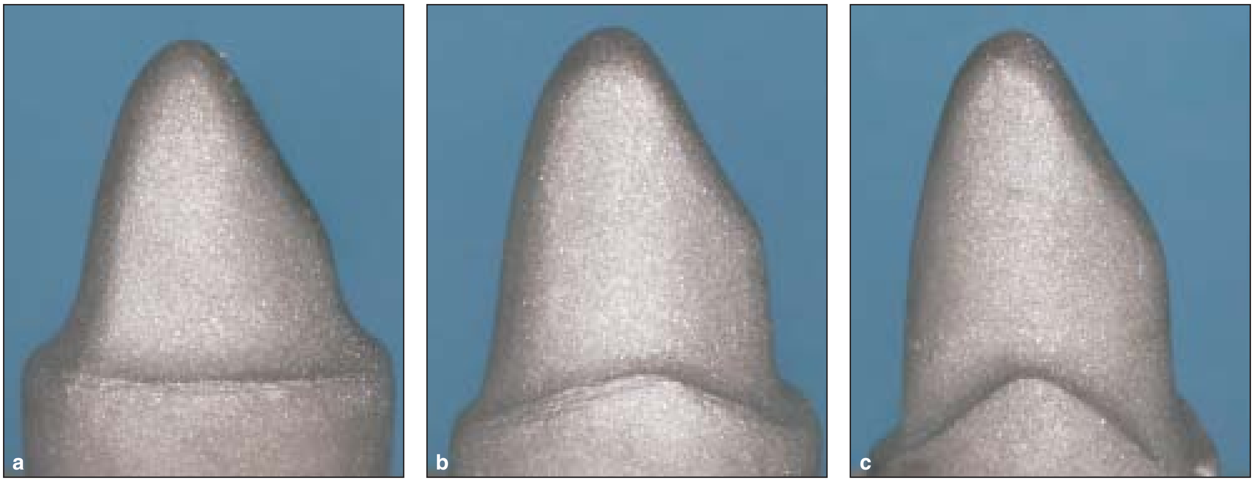

Fig 1 Dies of the right maxillary canine with the preparation line **(a)** at a constant preparation depth (C0) or differing by **(b)** 1.5 (C1.5) or **(c)** 3.0 mm (C3.0).

Table 1 Marginal Gaps (μm) of the Three Different Variations in Preparation Depth

	0-mm variation		1.5-mm variation		3.0-mm variation	
	Mesiodistal (0 mm)	Vestibulo-oral (0 mm)	Mesiodistal (0 mm)	Vestibulo-oral (1.5 mm)	Mesiodistal (0 mm)	Vestibulo-oral (3.0 mm)
Die (n)	C0 (n = 12)		C1.5 (n = 12)		C3.0 (n = 12)	
Mean gap	48	48	44	55	50	61
SD	18	21	22	25	24	26
Die (n)	P0 (n = 12)		P1.5 (n = 12)		P3.0 (n = 12)	
Mean gap	45	46	43	60	44	67
SD	18	16	22	27	17	21
Die (n)	C0 + P0 (n = 24)		C1.5 + P1.5 (n = 24)		C3.0 + P30 (n = 24)	
Mean gap	46	47	43	58	47	64
SD	18	19	22	26	22	25

SD = standard deviation.

marginal gap, a linear mixed model was created, with preparation depth and area as explanatory variables. Statistical analysis was performed using SPSS 17.0 (IBM) for descriptive analysis and PROC MIXED (SAS 9.2, SAS) for the linear mixed model. The level of significance was set at 5%.

Results

The copings of dies with a constant preparation depth showed no significant difference in the mean marginal gap discrepancy between the vestibulo-oral and mesiodistal regions ($P = .860$ and $P = .602$ for the canine and premolar, respectively). In contrast, the copings of dies with variations in preparation depths of 1.5 or 3.0 mm had significantly different marginal gap discrepancies ($P < .001$, Table 1 and Fig 2).

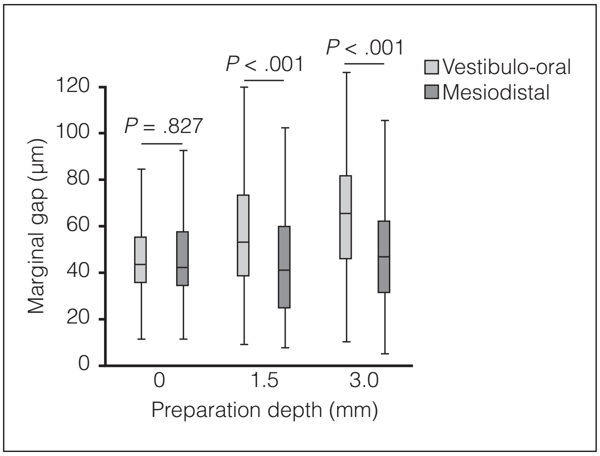

Fig 2 Box plot of the marginal gap of manufactured zirconia crown copings according to the difference in the preparation depth between the vestibulo-oral and mesiodistal areas.

Discussion

The use of dies prepared with a chamfer finish line and constant preparation depth as well as their subsequent conversion into dies with various preparation depths in the vestibular and oral regions was done to reduce differences in shape and dimension among samples, except in the region of the modified preparation line. Further, the cement space setting of 0 µm represented standard protocol.[3]

In this study, the mean marginal gaps ranged from 43 to 67 µm. These values are similar to those observed in other studies.[1,4] The mean marginal gaps for dies with a constant preparation depth in the vestibulo-oral (47 µm) and mesiodistal (46 µm) regions did not differ significantly, as expected. In contrast, the mean marginal gaps of dies with different preparation depths differed significantly between the vestibulo-oral and mesiodistal regions. With an increasing difference in preparation depth, the mean marginal gap became even larger (1.5-mm difference, vestibulo-oral: 58 µm and mesiodistal: 43 µm; 3.0-mm difference, vestibulo-oral: 64 µm and mesiodistal: 47 µm). This variability in the precision of the coping in the marginal area may be a result of the accuracy of optical detection being influenced by differences in preparation depth.[5] Another possible cause may be the limited precision of the milling process with increasing variation in preparation depth. Thus, these results support the hypothesis that increasing differences in preparation depth would lead to increased marginal gaps. A limitation of this study is that it could not simulate in vivo conditions completely and, thus, cannot be extrapolated to clinical situations.

Conclusions

Within the limitations of this study, it was demonstrated that increasing differences in preparation depth seemed to cause a greater marginal gap, determined using the optical scan system CEREC inLab.

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Literature Abstract

Novel CaF2 nanocomposite with high strength and fluoride ion release

Recent developments in the field of dental composites include incorporation of CaF2 nanoparticles into composites. The aim of this study was to investigate the effects of nanoCaF2 filler level and solution pH on the fluoride ion release and mechanical properties. Three nanocomposites were fabricated according to nanoCaF2 filler mass of 10% (nanocomposite10CaF2), 20% (nanocomposite20CaF2), and 30% (nanocomposite30CaF2), which amounted to a total filler level of 65%. A commercial composite with nano-sized fillers and fluoride ion release (Heliomolar, Ivoclar Vivadent) and a resin-modified glass ionomer (Vitremer, 3M ESPE) were used as controls. All samples were cured in $2 \times 2 \times 25\text{-mm}^3$ molds. Samples were subject to three-point flexure tests. The specimens were also placed in NaCl solutions buffered to pH 4, 5.5, and 7, and fluoride ion concentrations in these solutions were measured at 1, 2, 3, 7, 14, 21, 28, 35, 42, 49, 56, 63, 70, 77, and 84 days. The results showed that nanocomposite10CaF2 had the highest strength followed by nanocomposite20CaF2, with nanocomposite30CaF2 having similar strength to Heliomolar. After 84 days of immersion in the buffered pH solutions, nanocomposite10CaF2 and nanocomposite20CaF2 were both higher, compared to nanocomposite30CaF2 and Heliomolar. As for fluoride ion release, the trend showed a high initial increase followed by a slower steady release, and nanocomposite20CaF2 and nanocomposite30CaF2 had long-term release rates similar to Vitremer. The authors conclude that the nanoCaF2 composites have high strength and sustained release of fluoride ions and may have the potential to reduce secondary caries and restoration fracture.

Xu HHK, Moreau JL, Sun L, Chow LC. *J Dent Res* 2010;89:739–745. **References:** 36. **Reprints:** Dr Xu H.H.K, Department of Endodontics, Prosthodontics and Operative Dentistry, University of Maryland Dental School, 650 West Baltimore Street, Baltimore, MD 21201, USA. Email: hxu@umaryland.edu—*Y.L. Seetoh, Singapore*