X-ray Microtomographic Evaluation of the Influence of Two Preparation Types on Marginal Fit of CAD/CAM Alumina Copings: A Pilot Study

Maria-Eirini Krasanaki, DDS, MSc^a/Stavros Pelekanos, DDS, Dr Med Dent^b/ Marina Andreiotelli, DDS, Dr Med Dent^c/Spiridon-Oumvertos Koutayas, CDT, DDS, Dr Med Dent^d/ George Eliades, DDS, Dr Dent^e

This study evaluated the influence of two preparation types on the marginal fit of computer-aided design/computer-assisted manufacture (CAD/CAM) alumina copings. Two subgroups of four alumina copings each were fabricated using alumina master dies with either a chamfer or 90-degree shoulder preparation. Copings were scanned with an x-ray microtomographic scanner, and marginal fit was evaluated. The preparation types presented no statistically significant differences regarding marginal gap (P = .410) and absolute marginal discrepancy (P = .229). No correlation was found between marginal fit of CAD/CAM alumina copings and preparation type. Marginal fit could be considered within the limits of clinical acceptance. *Int J Prosthodont 2012;25:170–172*.

Marginal accuracy is a determining factor for both the periodontal status and long-term reliability of dental restorations. The term *misfit* is defined as a combination of gap and extension errors. The most meaningful parameter of misfit is the absolute marginal discrepancy (MD), which is an angular combination of the marginal gap (MG) and the over- or underextension error (Figs 1a and 1b).¹ The objective of this study was to evaluate the influence of two different preparation types (chamfer or 90-degree shoulder) on the marginal fit of computer-aided design/ computer-assisted manufacture (CAD/CAM) alumina copings. The null hypothesis was that there would be no statistically significant differences between mean MG and MD for both preparation types.

Materials and Methods

Two lateral incisors fabricated from a hard thermosetting acrylic resin material (AG-3, Frasaco) were circumferentially prepared with a 6-degree convergence, 6.0-mm height, 2.0-mm incisal reduction, and 1.2-mm chamfer or 90-degree shoulder. Four master dies of each prepared incisor were fabricated from presintered aluminum oxide material (Zeno Aleco Discs, Wieland) using a CAD/CAM system (ZenoTec, Wieland). Similarly, eight alumina copings were fabricated on each master die and divided into two subgroups regarding preparation type (chamfer or 90-degree shoulder). All specimens were scanned using an x-ray microtomographic scanner (model 1072, SkyScan) and read by the corresponding processing software (TView v1.1, SkyScan). A circle with 10 different diameters (every 18 degrees) was centered in the same position on every tomographic section (Fig 2). Both MG and MD were evaluated using vertical reconstructions of 20 microtomographic cross sections (Fig 3). Statistics were performed using factorial analysis of variance and least significant difference tests, employing Statistica 8.0 software (StatSoft). A power analysis to determine the sample size was not performed.

^aPrivate Practice, Crete, Greece.

^bAssistant Professor, Department of Prosthodontics, School of Dentistry, National and Kapodistrian University, Athens, Greece; Private Practice, Athens, Greece.

^cClinical Instructor, Department of Prosthodontics, School of Dentistry, National and Kapodistrian University, Athens, Greece; Private Practice, Athens, Greece.

^dAdjunct Senior Lecturer, Department of Prosthodontics, School of Dentistry, Albert-Ludwigs University, Freiburg, Germany; Private Practice, Corfu, Greece.

^eProfessor and Chairman, Department of Biomaterials, School of Dentistry, National and Kapodistrian University, Athens, Greece; Private Practice, Athens, Greece.

Correspondence to: Dr Stavros Pelekanos, 2, Thivon Str., 11527, Athens, Greece. Fax: +30 (210) 9532691. Email: pelekan@otenet.gr

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Figs 1a and 1b Diagrams of geometric measurements in different locations at the marginal area of an **(left)** over- and **(right)** underextended crown. A = internal gap; B = marginal gap; C = overextended margin; D = underextended margin; E = absolute marginal discrepancy; F = seating discrepancy. (Modified from Holmes et al¹ with permission.)



Fig 2 *(left)* Circle with 10 diameters positioned on a two-dimensional sagittal image.

Fig 3 *(below)* Vertical segment of an alumina coping on a master die. MG = marginal gap; MD = absolute marginal discrepancy.



Results

Mean MG values for chamfer (22.52 μ m) and shoulder (21.00 μ m) preparations had no statistically significant effect on the MG (F₁ = 0.68, *P* = .410). Mean buccolingual MG values (MGb/I) were higher than mesiodistal ones (MGm/d) for both chamfer

(MGb/I = 24.63 μ m, MGm/d = 20.29 μ m) and shoulder (MGb/I = 27.00 μ m, MGm/d = 14.88 μ m) preparations. Shoulder preparation presented a statistically significant difference between buccolingual and mesiodistal mean values (F₁ = 17.96, *P* = .000).

Mean MD values for the chamfer preparation (26.70 μ m) were higher than those for the shoulder

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preparation (23.41 µm), but without a statistically significant difference ($F_1 = 1.45$, P = .229). Mean buccolingual MD values (MDb/I) were higher than mesiodistal ones (MDm/d) for both chamfer (MDb/I = 32.46 µm, MDm/d = 22.54 µm) and shoulder (MDb/I = 31.67 µm, MDm/d = 15.71 µm) preparations at a statistically significant level ($F_1 = 17.11$, P = .000).

Copings with chamfer preparations exhibited 15% underextension, 6.25% overextension, and 78.8% equally extended margins, whereas copings with shoulder preparations demonstrated 17.5% underextension, 10% overextension, and 72.5% equally extended margins (Fig 4).

Discussion

X-ray microtomography is a nondestructive method that allows for measurements in different sections and distances along the marginal area, providing reliable three-dimensional reconstructions. Low magnification and possible refraction and edge-effect artifacts are the main disadvantages of this method, especially if the materials studied have similar x-ray absorption coefficients or demonstrate excessive x-ray scattering.²

A previous study of the marginal fit of different allceramic crowns showed an overall variation ranging between 17.18 μ m and 145 μ m.³ Regardless of the preparation type, the marginal fit of the alumina copings measured in the present study could be rated as good and within the clinically acceptable limits.

Different in vitro studies have shown contradictory results regarding the influence of the preparation design on the marginal fit of glass-infiltrated or densely sintered alumina crowns.⁴ In the present study, both MG and MD exhibited statistically significant differences between the buccolingual and mesiodistal aspects, which could be related to the material's deflection capacity and the parameters applied during the milling procedure.⁵ **Fig 4** Percentage of copings that exhibited underextension, overextension, or were equally extended to the preparation finish line.

Further research should assess the influence of other important factors such as cementation, veneering, and artificial aging (eg, load cycling, thermocycling). Furthermore, long-term clinical data are necessary before clinical recommendations can be made for everyday practice.

Conclusions

Neither chamfer nor shoulder preparations influenced the marginal fit of CAD/CAM alumina all-ceramic copings, which was found to be within the range of clinical acceptance. The CAD/CAM alumina copings following chamfer or shoulder preparations did not present marginal under- or overextensions. However, MG and MD seemed to be higher at buccolingual than mesiodistal sites.

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