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Short Communication

Internal and marginal accuracy of zirconia restorations made with two CAD/CAM systems

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Abstract. Introduction: Nowadays there are a lot of dental CAD/CAM systems and their number are increasing but there is a lack of information regarding which system produce the best marginal fit. Aim: The purpose of this study was to evaluate the internal and marginal fit of two different CAD/CAM systems (CERCON, DeguDent and CEREC, Sirona). Materials and methods: Twenty epoxy resin premolar dies (ExaktoForm, Bredent) were fabricated and twenty zirconia crowns. Ten zirconia crowns were fabricated using CERCON, DeguDent CAD/CAM system and ten using CEREC, Sirona CAD/CAM system. The internal and marginal fit of the crowns was analyzed using Bersoft Image Measurement 8.47. Results: Internal and marginal gap values between CERCON CAD/CAM system and CEREC CAD/CAM system were not significantly different (p=0.2). Conclusion: The CEREC system demonstrated larger internal and marginal gaps than CERCON crowns.

Key Words: Computer-Aided Design, CAD/CAM, accuracy, marginal fit, zirconia.

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Introduction

The term 'CAD/CAM' in dental technology is currently used as a synonym for prostheses produced by 'milling technology'. This is not entirely correct. CAD is the abbreviation for 'computer-aided design' and CAM stands for 'computer aided manufacturing'. The term 'CAD/ CAM' does not provide any information on the method of fabrication (Beuer et al 2008).

The advantages of using CAD/CAM systems include: the possibility of using new materials, reduced workforce, an improved cost-effectiveness ratio, quality control, permanently controlled workflow, industrialized manufacturing assuring a high quality, with the possibility to order materials depending on the particular situation to be solved, and without unnecessary costly and time-consuming adjustments, upgradings or repairs.

The Cercon smart ceramics system has been developed specifically for processing pre-sintered zirconia and the dental laboratory. For 10 years now, Cercon smart ceramics has been a hallmark of application reliability and clinical safety. Numerous scientific studies investigating a broad range of indications have shown that Cercon is just as safe as the gold standard of metal ceramics. Since the introduction of Cercon in 2001, more than 5.7 million restorative units have been produced worldwide (Degudent 2016).

The CEREC CAD/CAM system has been on the market for a good 30 years now and over 250 scientific studies have confirmed the clinical safety of tried and tested CEREC tooth restorations. Worldwide, more than 30 million tooth restorations have been produced with CEREC (Degudent 2016).

Accuracy of dental CAD/CAM crowns is crucial for the success on long term and inaccurate marginal fit is responsible for plaque retention, microleakage, inflammation process of the gingival tissue and finally, loss of prosthetic restoration (Kuhn et al 2015, Grenade et al 2011).

The accuracy of the marginal adaptation of fixed zirconium prostheses is influenced by the production technology (3MEspe). Several studies have reported that the marginal fit of CAD/CAM restorations is dependent on different factors that include margin configuration, die space thickness, the type of cement used, and the cementation technique. Suggestions that scanning, software, and machining have a detrimental effect on the fit of CAD/CAM restorations have also been made (Hamza et al 2013).

Zirconia has excellent aesthetic quality, biocompatibility and mechanical property. In addition, the price of zirconia is inexpensive compared to gold. Thus, zirconia is getting attention as a proper material for posterior teeth restoration to replace the existing ceramic (Ji et al 2015).

The objective of this study was to evaluate and compare the internal and marginal accuracy of single zirconia crowns fabricated with two different CAD/CAM systems (CERCON, DeguDent and CEREC, Sirona). The null hypothesis was that the accuracy of single zirconia crown is influenced by the CAD/CAM system.

Materials and methods

For the purpose of this study the first maxillary premolar from a Frasaco AG-3Z model was duplicated using a duplicating silicone (Exaktosil N21, Bredent, Germany). This silicone mold

Fig. 1. ExaktoForm die and CERCON zirconia crown

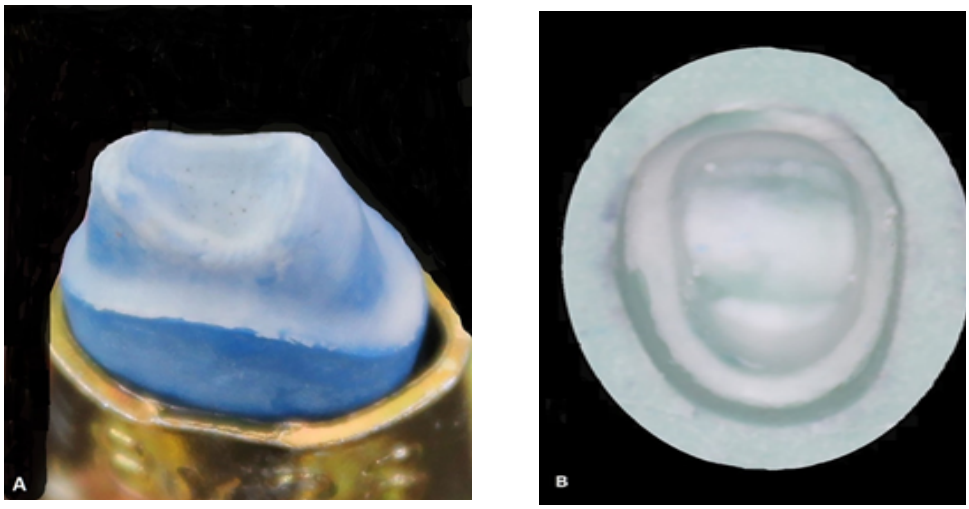

Fig. 2. The silicone film of VPES silicone on the die (A) and stabilized with putty silicone (B)

was used to obtain 20 dies fabricated from a polyurethane resin (ExaktoForm, Brdent, Germany) that was chose for its accurate reproduction and maximum edge stability. The same clinician made all the abutments. The extremely high fluidity of this resin allows pouring of impressions with high precision and without the formation of bubbles. True to the original and accurate reproduction of surfaces and perfect dimensional stability as well as superior precision of fit without expansion are distinctive features of this model resin (Bredent).

Ten of the experimental dies were used for fabricating ten zirconia crowns using the CERCON, DeguDent CAD/CAM system (scanner: CERCON Eye, DeguDent; CAD-software: Cercon Art, DeguDent; CAM-unit: Cercon Brain, DeguDent) (Fig. 1). The other ten dies were used for fabricating ten zirconia crowns using the CEREC, Sirona CAD/CAM system (scanner: inEOS X5, Sirona; CAD-software: inLab4, Sirona; CAM-unit: inLab MCXL, Sirona). The CERCON and CEREC prosthetic restorations were fabricated using the same parameters: full anatomical contour, 20 μm cement spacer and a collar position of 1,2 mm above the cervical line.

The crowns were filled with vinyl polyether silicone (VPES) for checking fit (Fit Checker Advanced White, GC Dental Products, Japan). Then the zirconia crowns were placed onto the dies and loaded with finger pressure in the occlusal direction. After the VPES silicone had set, the crowns were removed and the silicone film of Fit Checker was stabilized using putty polysiloxane impression material (Zetaplus, Zhermack) (Fig. 2).

The silicone replicas of teeth were sectioned with a surgical blade (Swann Morton No.10) in vestibular-oral direction, 1mm thinly sliced. Four central slices were chosen for each crown and five measurement points per slice: two for marginal accuracy and three for internal gap (Fig. 3).

Each slice of the replica was scanned using a flat-bed scanner (HP Deskjet 3050 J 610 series) at 1200 dpi and all the digital datasets were imported into the Bersoft Image Measurement 8.47 inspection software.

Statistical analysis was performed with Analyse-it statistical software. The data were expressed in means and standard deviations (SD). Student's t-test for independent variables was used to evaluate the difference between the two groups.

Results

The means of the silicone films thickness for CERCON CAD/CAM system (N=20) was M= 2.39 data units (SD= 0.18) (Fig. 4) (the tool specifies the distance in data units determined by the XData and YData properties, which is pixels, by default) (www.mathworks.com). By comparison, CEREC CAD/CAM system (N=20) was associated with a numerically bigger means of the silicon films thickness M= 2.47 data units (SD= 0.21).

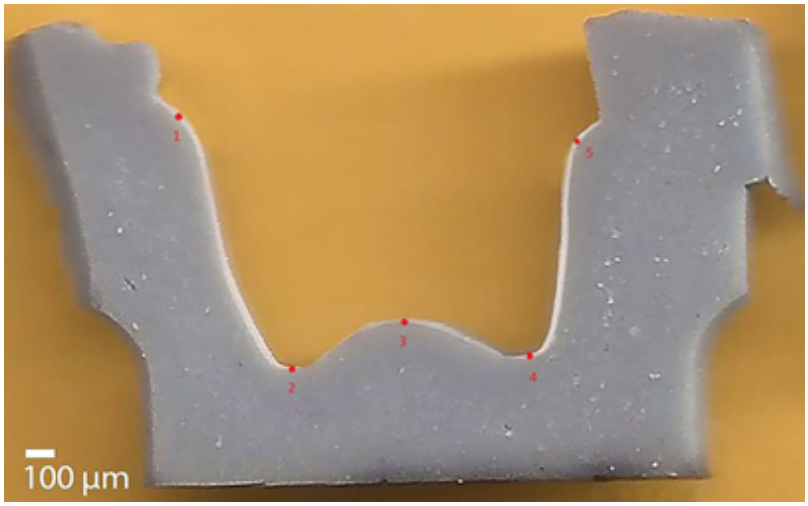

Fig. 3. Measurement points for marginal and internal gaps: 1 and 5 for marginal accuracy; 2,3 and 4 for internal fit of the zirconia crown

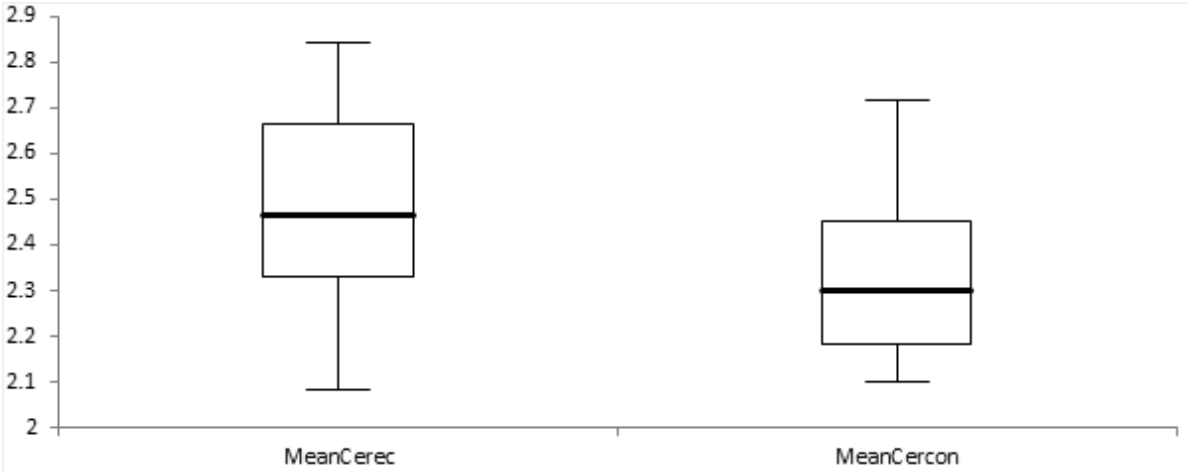

Fig. 4. Box-plot diagrams for the mean values for CEREC and CERCON groups

There was statistically significant differences between the two CAD/CAM systems, on the internal and marginal gap (p=0.2).

Discussions

There are many and various criteria about the clinically acceptable marginal fit of prosthetic restoration (Ki-Hong et al 2015, Sulaiman et al 1997).

In the present study, the internal and marginal accuracy of monolithic single crowns, manufactured using different CAD/CAM system from zirconia blanks, was evaluated. The results support the rejection of the null hypothesis, that there would be difference in the marginal and internal gap of zirconia CAD/CAM crowns made with different CAD/CAM systems.

Various techniques for determination of fitting accuracy have been described in the literature: cross-section technique (Beuer et al 2009, Beuer et al 2008), direct microscope measurement (Gonzalo et al 2009, Vigolo et al 2008), replica technique and computer-aided 3D evaluation (Bornemann et al 2002). For the purpose of the study, the replica technique was used to evaluate the accuracy of zirconia crowns. This method has been used by numerous authors (Tinschert et al 2001, Coli et al 2004, Khorst et al 2011) and has the advantage that neither restoration nor abutment have to be destroyed during the process (Khorst et al 2009).

The limitation of this study is that evaluation of the specimens was realized in a non-cemented condition and it does not entirely reflect the final accuracy of the restoration because of the different flow property of the luting agent is not identical with that of the VPS silicone used. Another limitation of the study was the number of measurements per specimen after sectioning which is limited and may not be representative and finger pressure used was not standardized.

Future studies should be performed in order to develop an experimental method to measure the internal fit of crowns fabricated with CAD/CAM systems.

Conclusions

The CEREC system demonstrated larger internal and marginal gaps than CERCON crowns.

Within the limitations of this study, marginal and internal gaps of both CAD/CAM systems do not differ and show clinically acceptable marginal gaps.

No significant differences in marginal and internal fit were found between CERCON and CEREC CAD/CAM zirconia crowns.

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