RESEARCH ARTICLE

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Biotechnological innovations in clinical application of zirconia-based ceramics for indirect restorations

ABSTRACT

Introduction: Fast progress of digital technology, combined with the integration of bioengineering sciences reveals unlimited possibilities for the dentists. These advances have catalyzed the developments of aesthetic all ceramic restorations with superior biomechanical properties.

Aim: The aim of the present study is to present a biotechnological approach for indirect restoration with xirconia-based ceramics.

Materials and methods: Treated teeth are colour measured with two digital devices and with an intraoral scanner. A digital impression is taken with the intraoral scanner of the preparation, the adjacent teeth, the antagonist and the occlusion. The data has been sent to the lab computer. The digital impression is compared to a conventional one with the programme Convince Standard. The intraoral scan is used for modelling of the future restorations and virtual articulation by the CAD software. In the end the restoration is processed for milling by the CAM module.

Results: The following steps of a digital way for indirect restoring with Zirconia bioceramics are illustrated: colour measurement, intraoral scanning, impression comparison technique, 3D modelling and virtual articulation and a final stage of milling.

Conclusion: From the present study can be concluded that the new restorative materials are highly technologic decisions. Although the optimal use of CAD/CAM biotechnology must be determined on a case-by-case basis, they give the clinicians the opportunity to utilize digital innovations in patient's therapy to provide more highly efficient, long-lasting and potentially good outcomes.

Key words: biotechnology, digital, Zirconia, restorations

Introduction

Fast progress of digital technology, combined with the integration of bioengineering sciences reveals unlimited possibilities for the dentists. These advances have catalyzed the developments of aesthetic all ceramic restorations with superior biomechanical properties. Since these materials have proved to be inimical to conventional dental processing technology, new sophisticated processing technologies and systems have been anticipated for introduction into dentistry. One solution to this is the introduction of computer-aided design and computer-aided manufacturing (CAD/CAM) technology (Figure 1) (Miyazaki et al., 2009).

The aim of the present study is to present a biotechnological approach for indirect restoration with Zirconia-based ceramics.

Materials and Methods

In the present research were included vital, vastly devastated upper and lower molars. Each tooth was selected according to specified criteria. The study was conducted in the Faculty of Dental medicine, Department of Operative dentistry and Endodontics, Plovdiv, Bulgaria.

The research was proceeded after obtaining informed consent from every patient and was conducted according to the principles expressed in the Declaration of Helsinki. The clinical part was approved by the Ethic committee on scientific researches of Medical University of Plovdiv (P-1802,14.07.2015).

The colour of each tooth was evaluated in three zones: cervical, medium and incisal. The results were collected in individual cards for colour measurement, prepared especially for the research. The following devices were used for colour measurement:

- VITA Easyshade Advance 4.0: works on the basis of digital system for colour measurement and spectrophotometer

with a range of 400-700 nm. The device can work with the shade guides VITA classical A1-D4 and VITA 3D-MASTER. VITA Easyshade can automatically recognize when the tip is properly situated in order to accomplish precise measurement (Figure 2);

Figure 1. *CAD/CAM technology.*

- SpectroShade ™ MICRO (MHT) Optic Research AG): a combination of numeral device and LED spectrophotometer with a range of 410-680 nm; ability for working with different shade guides. The device is placed closely to the gingiva in such a way that the radiate light falls under 45° on the tooth surface and the light that turns back into the device is with angel of 0º to the detector. The tooth is well captured when: the tooth is centered, an equal part of the gingiva and of the mouth cavity is pictured in the image, when the angle of capturing is indicated with a green circle in the left lower part of the screen (Figure 2);

- Intraoral scanner (Trios 3Shape). A digital impression is taken of the prepared tooth, the adjacent teeth, the antagonists and in occlusion with the intraoral scanner. The colour of the prepared tooth is defined by previously colour calibration of the camera according to two shade guides- VITA Classical and VITA 3D-Master. (Figure 3) The data is sent to the laboratory computer.

After taking and scanning with the laboratory scanner of the conventional impression, a comparative analysis was made between the digital and the conventional impression. For this aim we used the programme Convince Standard. We assumed for reference model the digital one. With the programme Convince Standard we discovered by value and colour the differences between the two impressions. We found no discrepancy between the digital and conventional impression in some of the zones, shrinkage and expansion in others.

Figure 2. *Colour measurement with spectrophotometric devices.*

We used the intraoral scan for modelling the future restoration. The preparation margin was marked, as well as the insertion direction and the thickness of the cement were set, removing the ledges, if it is needed was made. The anatomical characteristics of the chosen tooth were designed, as well as the contacts between the construction and the cavity, the construction and the adjacent teeth and between the construction and the antagonists. At the final stage the indirect restoration was milled by the CAD modulus of the system (CAM 5-S2) (Figure 4).

Results

In the present study the following steps of a digital way for indirect restoring with Zirconia bio-ceramics are illustrated:

1. Colour measuring with two digital spectrophotometric devices and intraoral scanner;

2. Intraoral scanning of the prepared tooth, the adjacent teeth, the antagonists and in occlusion;

3. Comparative numeral and colour analysis of conventional and digital impression techniques;

4. 3D modelling and virtual articulation by the CAD software;

5. Final stage of milling the construction by the CAM modulus from Zirconia bio-ceramic material (UTML Katana Zirconia, Kuraray Noritake Dental Inc.).

Figure 3. *Colour measurement and scanning with an intraoral camera.*

Discussion

CAD/CAM systems give the opportunity for working with new restorative materials with improved biological, mechanical and aesthetic characteristics. (Palin et al., 2009) Zirconia bioceramics are distinguished with excellent features such as: high tensile strength, very good fracture resistance, resistance to corrosion, very good optical qualities and biocompatibility.

The CAM modulus allows the production of restorations that can imitate the individual anatomical characteristics of the patient's teeth. The restorations are also featured with very good marginal adaptation and occlusal contacts. In addition the CAD/CAM systems give the opportunity for producing a restoration for a shorter period of time than traditional dental methods and procedures.

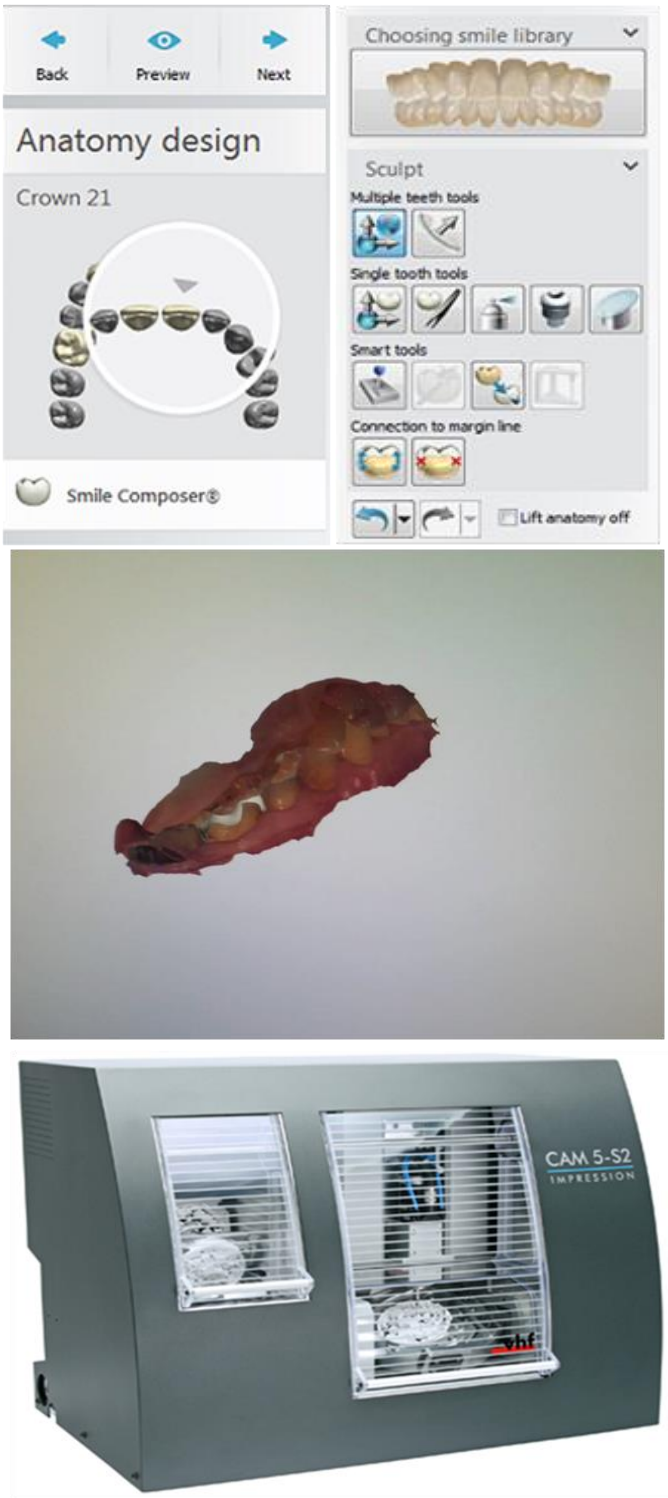

Figure 4. *Designing and milling of the future restoration.*

As the survival rate of these restorations is regarded, there are a large number of published clinical studies (Fasbinder,

2006). Posselt and Kerschbaum (2003) reported on 2,328 inlays and onlays placed in 794 patients fabricated with CEREC. The Kaplan-Meier method survival probability was 97.4% at five years, and it was 95.5% at nine years. The longest clinical study to date on CEREC restorations regularly evaluated 1,011 over 18 years and reported a Kaplan-Meier survivability of 95% at 5 years, 91.6% at 7 years, 90% at 10 years, and 84.9% at 16.7 years (Reiss, 2006).

A growing list of published studies document the accuracy of the more recently introduced digital impressions as at least equal to that of conventional impressions (Ender & Mehl, 2011; Scotti et al., 2011; Abdel-Azim et al., 2015). According to Fasbinder et al., 2012a there is evidence that digital systems can be more accurate than conventional master impressions and dental stone models. Fasbinder (2012b) emphasizes that to consistently capture accurate impressions with this technology, the dental team must continue to rely on traditional skills such as achieving optimal soft-tissue retraction and maintaining moisture control and isolation. Like a comparison of the absolute mean discrepancies in the three zones (margin, axial and occlusal surface) showed that the amount of discrepancy from the reference tooth was smallest on the occlusal surface and largest on the margins. This means that the accuracy of the margin is affected by the position. The occlusal surface, which is at the outermost to contact easily with the impression materials, showed the best accuracy (Renne, 2014).

Several clinical studies have confirmed that computer assisted shade analysis is more accurate and more consistent compared with human shade assessment. The advantages are no influence of surroundings or lighting and the results being reproducible (Chu & Devigus, 2004). In another study is shown that most digital devices had similar high reliability (over 96%), indicating predictable shade values from repeated measurements (Kim-Pusateri et al., 2009). Our investigation has shown that the digital methods are modern way for additional analysis in support of the right choice and precise recreation of the future indirect restoration.

The disadvatnages of this technology are related with their still high cost, the need for education for working with the software, the need for calibration of the separate modulus of the system, resolution and precision of the scanning device as well as the sensitivity of the system to accumulation of operator's mistakes during the working flow.

From the present study we can make the conclusion that the new restorative materials are highly technological decisions. Although the optimal use of CAD/CAM systems should be defined on case-by-case basis, these systems give the clinicians the opportunity to apply the digital innovations in the treatment of their patients, aiming at more effective, long-lasting and potentially good results. That is why future researches on their possibilities can help form the future of the modern dental medicine.

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