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APPLICATION OF 3D DIGITAL SCANNING AND CAD/CAM SYSTEMS FOR ZIRCONIA INDIRECT RESTORATIONS

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ABSTRACT

Object: To study the CAD/CAM systems' possibilities for manufacturing Zirconia indirect restorations for restoring vital, vastly devastated teeth.

Material and methods: Five patients with vital, heavily destroyed molars were included in the clinical study. The teeth were prepared according to requirements for Zirconia restorations. The impressions were taken with 3D intraoral scanner. The acquired data is transmitted electronically for designing the future restoration by the CAD software. After designing, the restoration is milled by the CAM module and sintered, according to a specially projected programme in accordance with the manufacturing demands. After clinical check-up, the restorations are glazed, air-blasted and cemented.

Results: Setting up an individual protocol for working with CAD/CAM systems for restoring vital, severely devastated teeth with Zirconia indirect restorations. A research is made on 3D digital scanning, occlusal and proximal modeling, virtual articulation, analyzing the incline of the cavity walls, the thickness of the restoration and the possibilities for restoring the anatomy of the tooth according to patient's individual characteristics of the teeth's arch.

Conclusion: The scanning and design process should be evaluated with the same quality control as when using traditional methods. The CAD software requires excellent preparation of the tooth cavity and digital scanning. This is the reason why these systems require a thorough understanding of CAD/CAM calibration and parameters of the product to be clinically acceptable. Once understood, CAD/CAM dentistry can create detailed and accurate restorations that function and perform with great success and longevity.

Key words: CAD/CAM, digital, indirect, restorations.

INTRODUCTION

The fast progress of digital technologies has already taken its place in the modern dentistry. In the beginning the development of CAD/CAM (Computer-Aided Design/Computer-Assisted Manufacturing) for clinical dentistry was established for single-tooth fabrication of indirect restorations. [1] Initially, these CAD/CAM systems were designed to handle with restorations such as inlays, onlays, crowns, and veneers [2]. Today, both chairside and laboratory - based CAD/CAM systems have evolved to provide a broader scope of clinical applications and products for dentistry [3].

CAD/CAM in dentistry has been particularly useful in enabling the fabrication of custom, patient-specific restorations and prosthetics without the need for traditional analog dental laboratory methods [3.]In that way the clinician has the opportunity to model and produce a certain restoration in an easy and efficient way in one single patient's appointment. The evolution of such technologies leads to a significant change in the clinicians' way of thinking, attitude and way of treatment.

OBJECT

To study the CAD/CAM systems' possibilities for manufacturing Zirconia indirect restorations for reconstructing vital, severely destroyed teeth.

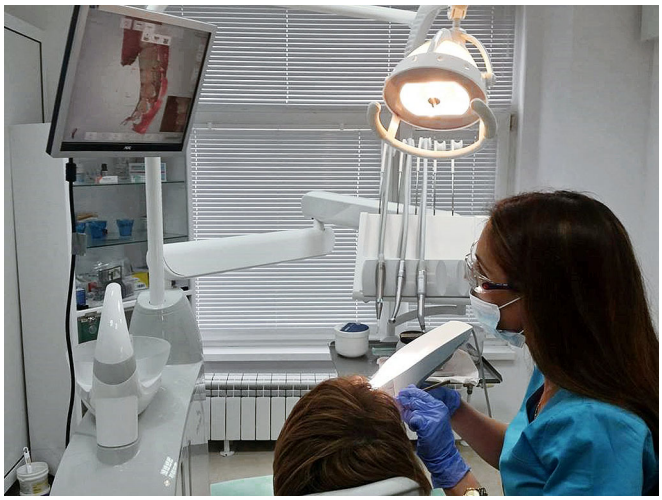
MATERIAL AND METHODS

Ten restorations are made on five patients (two on each patient) between 18 and 65 years old. The teeth are prepared according to requirements for Zirconia indirect restorations and in accordance to the CAD software demands (Fig.1a, b, c).

Fig. 1 a, b, c. Vastly destroyed molars with amalgam and composite fillings, planned for a new restoration;

The impressions are taken with 3D intraoral scanner (Trios 3Shape). Every scanning begins with setting a new order with patient's and clinician's names, marking the tooth, type and material that will be used for the specific restoration (Fig.2).

Fig. 2. Scanning process;

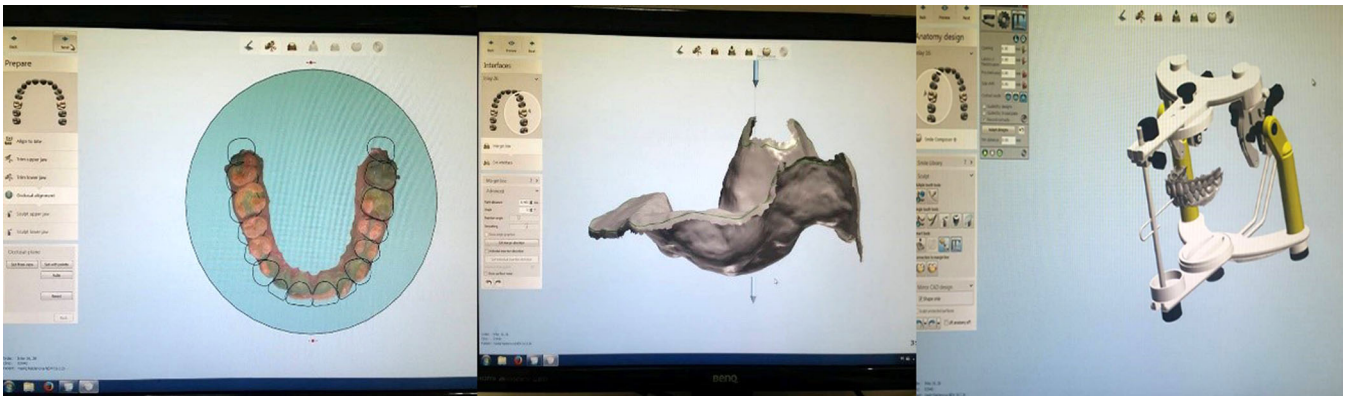


Several scans are taken: of the upper, lower jaw and in occlusion with possible two bites if necessary (right and left). Specific attention is paid to the tooth, which will be restored, the margins of the preparation, its neighbourhood teeth and the antagonists. In order to design an accurate and precise restoration, no scanned data should be missed. The acquired data is transmitted electronically to the laboratory for use in multiple applications, including analyzing, designing the future indirect restorations and their fabrication.

The design of the restoration is made by a CAD software (3Shape Dental System). The CAD programme provides all the necessary tools to virtually design the restoration on the computer monitor and the following steps are accomplished for each of the restorations:

- Occlusal alignment;
- Outlining the margin's line of the tooth and setting the placing direction of the restoration;
- Setting the cement's thickness, removing the cutouts if necessary;
- Modeling the anatomy of the future restoration and its thickness;
- Shaping the contacts between the restoration and the cavity, the neighboring teeth and the antagonists-virtual articulation (Fig. 3a, b, c).

Fig. 3 a, b, c. Designing the future restoration;

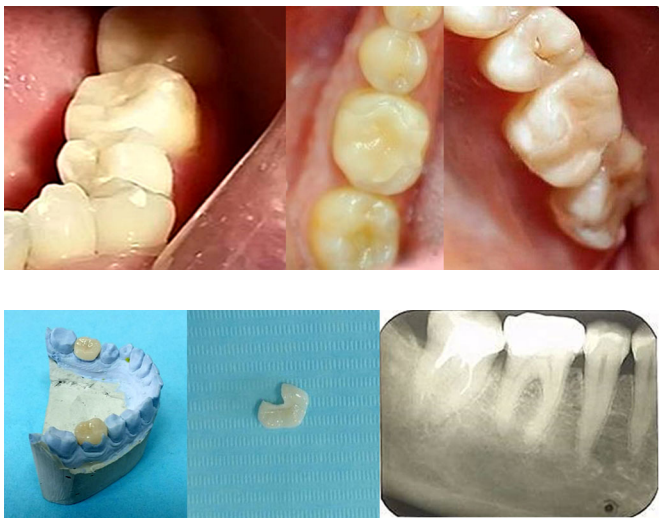


The designed restoration is situated on the disc and processed for milling by the CAM module (vhf milling machine). All restorations are made from Ultra Translucent Multi Layered (UTML) Zirconia discs (Kuraray Noritake Dental Inc.).

The milled Zirconia indirect restorations are sintered, according to a specially projected programme in accordance with the manufacturing demands. After clinical check-up, the restorations are glazed and air-blasted.

In the final stage the restorations are cemented following an individually established protocol. All restorations and their proximal contacts are followed up by X-rays (Fig.4 a, b, c, d, e, f).

Fig. 4 a, b, c, d, e, f. Fabricated Zirconia indirect restorations, followed clinically and by X-rays



RESULTS

Setting up an individual protocol for working with CAD/CAM systems for restoring vital, devastated teeth with Zirconia indirect restorations. A research is made on 3D digital scanning, occlusal and proximal modeling, virtual articulation, analyzing the incline of the cavity walls, the thickness of the restoration and the possibilities for restoring the anatomy of the tooth according to patient's individual characteristics of the teeth's arch.

DISCUSSION

There are a significant number of published clinical studies on chair side CAD/CAM restorations [3]. A study of 2,328 inlays and onlays placed in 794 patients reported a Kaplan-Meier survival probability of 97.4% at 5 years, and 95.5% at 9 years [4]. Berg and Dérand reported in a 5-year study on CAD/CAM indirect restorations that only 3 of 115 inlays were found to be fractured [5].

The quality of digital impressions, especially compared to their conventional analogues is presently discussed in a controversial manner [6]. 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 [7, 8, 9]. In contrast Ender et al. showed that digital impressions were less accurate than conventional ones in terms of both trueness and precision [10]. Other authors claim that the marginal fit and internal adaptation of the restorations was significantly better for those made with digital impressions compared with traditional impressions [11, 12].

As pointed out by Gimenez et al., the achievable accuracy of digital impressions also depends heavily on operator skills [13]. In addition some studies have reported that the scanning strategy influences the accuracy of the resulting impression [14, 15].

Like any dental instrument, both the digital impression system and chair side CAD/CAM system require proper setup, consistent intraoral protocols, and calibration of milling parameters to ensure exceptional clinical results [16].

CONCLUSION

The scanning and design process should be evaluated with the same quality control as when using traditional methods. The CAD software requires excellent preparation of the tooth cavity and digital scanning. This is the reason why these systems require a thorough understanding of CAD/CAM calibration and parameters of the product to be clinically acceptable. Our clinical study continues and all indirect restorations will be clinically and radiographically checked. The research and evidence of the effectiveness of CAD/CAM dentistry will help shape the future of all clinical dentistry.

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