DIRECT RESTORATIONS AND 3D-PRINTING: FROM THE COMPUTER TO THE TOOTH

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ABSTRACT:

Introduction: The use of digital technology in dentistry is already part of the routine of many dentists and laboratories, after the development and improvement of the CAD/CAM and 3D-printing technologies. **Methods:** By means of a case report, a digital workflow for image acquisition and restoration of a fractured tooth in a virtual manner and 3D-printing will be presented, making it easier to obtain a final resin composite restoration. **Results:** The described technique allowed for a final restoration with high levels of aesthetics and function, in which the digital workflow made it possible to achieve an exact copy of the lost dental structure. **Conclusion:** The described clinical case presents a simple and highly predictable way of performing direct resin composite restorations of teeth that need their anatomy to be replicated.

KEYWORDS: 3D-printing. Resin composite. Direct restoration.

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INTRODUCTION

With the growth in the use and success of three-dimensional (3D) technology, topics related to digital Dentistry are now everywhere, which can be found just by navigating the pages of our social networks, scientific articles, and clinical case reports. Advances in this technology currently present a major impact on Dentistry. In addition to the already widely used and well-studied CAD/CAM technology (computer-aided design/computer-aided manufacturing), reports have shown the use of 3D printing for different purposes[1-9].

Among the different techniques used for 3D printing, the most popular one among dentists is the so-called stereolithography (SLA). This methodology makes use of photopolymers that are held in a container controlled by a Z-axis, where the final three-dimensional structure results from direct exposure of the polymer to light when the sample holder moves up or down[7].

Since the advent of CAD/CAM imaging and milling systems, which have literally created a new modality of clinical Dentistry[10], to the development of 3D printers, great strides have been made to improve the different components of this technology, in order to facilitate its access, use and availability for clinical, pre-clinical and research purposes. More affordable 3D printers, along with easy-to-use open source software, offer opportunities for the use of 3D printed polymer-based materials in all fields of Dentistry, allowing them to be used in-office as well.

Recent studies have shown a number of results obtained with the 3D printing technique, such as: 1) the comparison of marginal and internal adaptation of resin restorations, showing significantly lower results of marginal and internal gaps when compared to milled restorations in CAD/CAM[1]; 2) the performance of a clinical workflow for fully digital rehabilitation, beginning from the acquisition of working models until the execution of veneers to be cemented in the patient's mouth, presenting clear advantages compared to the conventional casting technique, such as faster working time and prevention of problems such as distortion of impressions and models[2]; 3) fabrication of a die-trimmed cast to replicate gingival tissue and implant analogs[3]; 4) fabrication of accurate 3D-printed artificial teeth for preclinical use, done by scanning natural teeth[4]; 5) evaluation

of the accuracy of dental models manufactured by the CAD/CAM milling method, compared to the 3D printing method[5]; 6) performance of a digitally guided technique to provide references for gingival manipulation and bone resection during clinical crown lengthening surgery, which facilitates the surgical procedure and increases the predictability of the treatment[6]; 7) *in vitro* performance of 3D printed single provisional crowns, with results suggesting that commercial dental restorative material available for 3D printing allows for mechanical properties sufficient for intraoral use of temporary restorations;[7] 8) 3D printing of zirconia crowns, with *in vitro* results that meet the accuracy requirements, showing to be suitable for the manufacture of zirconia crowns, when compared to crowns milled in CAD/CAM[8]; 9) implementation of surgical guides for implants[9], among others.

When both digital systems are compared, the CAD/CAM system uses a subtractive technique, while the 3D printing technology uses an additive technique. This means that, in the subtractive technique, the restorations are milled from large blocks using different drills. However, approximately 90% of the prefabricated block is wasted during this process[11]. On the other hand, the additive technique is an alternative process with minimal waste, defined as the process of joining materials to make objects from 3D model data, usually layer upon layer[12].

The clinical case presented in this article aims to provide a clear workflow for the use of this new 3D technology. In general, it is a clinical case of a dental fracture, in which the patient's upper arch was scanned using an intraoral scanner, and the fractured tooth anatomy was restored by copying the adjacent tooth digitally through an open software, thus avoiding the need for impression materials, models and wax-up. The assembly was printed by the 3D printer for the realization of guides for direct restoration in resin composite, as performed conventionally.

CASE REPORT

The presented case is from a male patient, 11 years old, who came to a private practice with a non-complicated coronary fracture of tooth #11. After observing the absence of color changes, vitality tests, radiographs and initial photographs (Fig 1), the procedure of choice was the direct restoration with resin composite. A virtual impression was made with an intra-oral scanner (Cerec Omnicam, Dentsply Sirona) and the patient was scheduled for one week later, to avoid excessive psychological trauma.

The digital impression was converted to an .STL file using the Cerec SW 4.6 software, which allows the free exportation of the .STL files, and taken to an open source software (Autocad Mesh Mixer) (Fig 2). In the software, the tooth #21 was copied and mirrored to the tooth #11, in order to mimic its anatomy (Fig 3). Within the tools of this software, there is the possibility of modifying dimensions of what was selected, allowing for a better adaptation of the space to be restored. After a perfect matching, the 3D printing of the model was performed, in order to obtain the guides for the direct restoration with resin composite (Fig 4). Printing was performed on a 3D printer with SLA technology (Form2, Formlabs) with a resolution of 25 microns.

Figure 1:
Initial photo of the patient's smile with a coronary fracture of tooth #11.

Figure 2:
Initial photo of the fractured tooth and obtaining the virtual model.

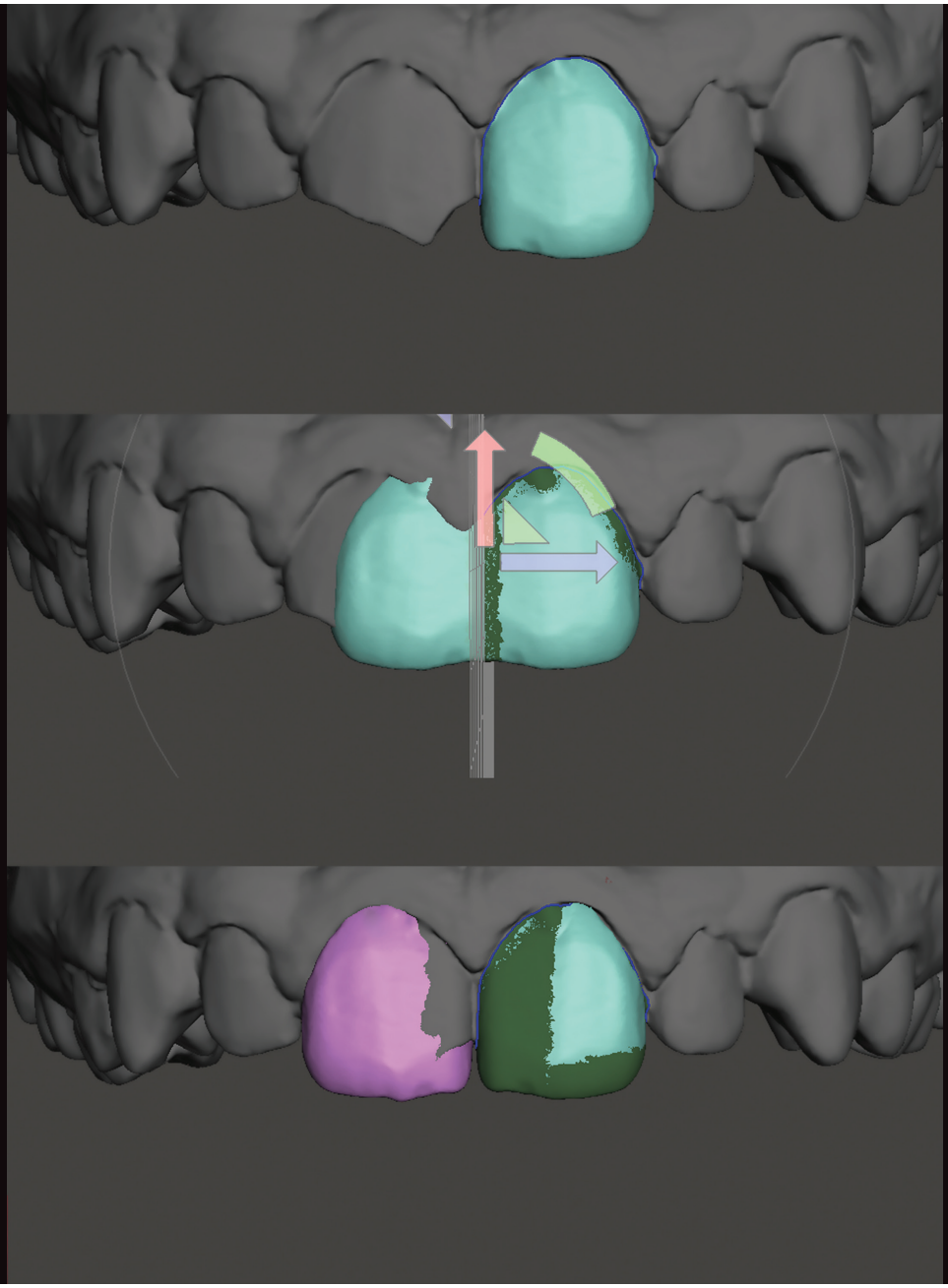


Figure 3:
Performance of a mirrored copy from tooth #21 to tooth #11. For this purpose, the delimitation of the tooth to be copied (in this case, tooth #21) is performed, and mirroring is performed for the tooth #11. After that, overlapping of this mirror is positioned over the required tooth.

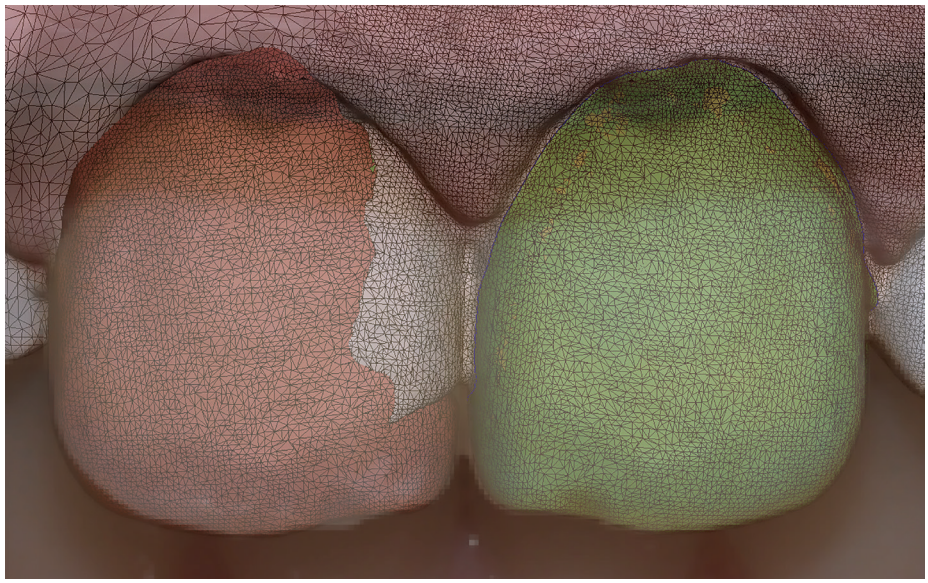
After one week, vitality test and color observation procedures were re-evaluated. Subsequently, the direct restoration was performed in a conventional incremental manner (Fig 5). After the restoration was finished, a photograph was taken of the patient's smile (Fig 6). The final photograph was then superimposed over the virtual model's image created in the software from the mirroring of the adjacent tooth (Fig 7).

Figure 4:
After performing the restoration of the fracture digitally, the model is printed in a 3D printer (Form2, Formlabs) and a silicone guide is made to allow for the restoration with composite resin.

Figure 5:
Restoration being performed in a conventional manner, incrementally and according to the layers of dentin, enamel, transparent and white dye, in order to mimic the staining from the adjacent teeth.

Figure 6:
Final photo of the smile of the patient after restoration of the right central incisor (tooth #11).

Figure 7:
Superimposition of the teeth and the virtual model obtained from mirroring of the adjacent tooth.



CONCLUSION

Despite the great "boom" in digital Dentistry, there is still a learning curve related to the use of scanners, softwares, and 3D printers, as well as a relatively high initial cost for pre and post-processing procedures, which still limits the use of such technologies in the day-to-day dental practices. However, companies are investing in developing and trading low-cost or more affordable printers, so that in the short term, this tends to be part of the dentist's routine. By performing a provisional crown in about 20 minutes, it is not difficult to imagine a clinical situation in which a tooth is prepared, scanned, sent to a 3D printer, and cemented a few minutes later, potentially increasing the clinic productivity[7].

This clinical case presents a simple and highly predictable way of performing direct restorations of teeth whose anatomy needs to be replicated, by scanning and copying an existing adjacent tooth, allowing for returning a perfect aesthetic and function to the patient, with a high level of acceptance. In addition, archives can be digitally stored, saving material, time and space, without the need to store models in offices with square meters more and more disputed, and making it possible to obtain the exact same work either virtually or printed at any time, just by a "click". The idea of incorporating such technologies is to make tasks that are currently carried out artisanally, in a faster and more efficient manner.

If someone says that using 3D tools is the future of Dentistry, I believe this someone is mistaken; for a few years, such technologies are already part of the routine of many dentists and laboratories; in a few years more, they will become routine for all of us.

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» Patients displayed in this article previously approved the use of their facial and intraoral photographs.