# COMPUTER-AIDED WORKFLOW IN ORTHODONTIC MINOR TOOTH CORRECTION: A CASE REPORT

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## ABSTRACT

**Aim of the study:** The objective of this study was to highlight the computer aided workflow for minor tooth correction in an adult case using oral splints. **Material and methods:** An intraoral scanner (3Shape Global, Copenhagen, Denmark) was used for performing digital impressions and a set of 3D printed casts (Photocentric® 3D printer, Photocentric Ltd, Peterborough, UK) for aligners manufacturing using the vacuum thermoforming procedure (Ministar S® machine, SCHEU-DENTAL GmbH, Iserlohn, Germany). A "guide" splint for composite buttons attachment, and four active orthodontic splints were realized. Following tooth alignment, a porcelain veneer was performed on the upper first premolar and fixed retention was established. Another intraoral scanning (assisted for accomplishment of a retainer) was performed for obtaining a 3D printed model that served as a guide for the final retention splint. **Results:** All orthodontic aligners and the retention splint were realized using digital technology (CAD/CAM). The workflow was less time consuming, comfortable for the patient and the treatment outcome could be predicted with high accuracy. The outcome was excellent in terms of aesthetics and functionality. **Conclusions:** For minor tooth movements in adult patients, computer-aided workflow can be implemented, with positive results.

**Key words:** oral splint, tooth movement, CAD/CAM, digital workflow, retention

## INTRODUCTION

In dentistry, Computer Aided Design/Computer Aided Manufacturing (CAD/CAM) technique enables practitioners to accomplish effective and precise restorations; having applications in prosthodontics, oral and maxillofacial surgery, implantology, periodontology, orthodontics [1]. In orthodontics, it can be used for both diagnosing and treatment purposes [2], offering numerous advantages for both the practitioner and the patient, as it improves precision, treatment time, and predictability [3]. In digital technology, an intraoral scanning, as well a bite registration in order to use CAD/CAM technology are needed [4]. Imaging technology has various advantages in all dental fields, including digital orthodontic procedures [5].

The objective of this study was to highlight the computer aided workflow for minor tooth correction in an adult case using oral splints (aligners).

## MATERIAL AND METHODS

A 48-year-old-woman visited our

department for esthetic reasons due to a space between the upper left lateral incisor and canine as well as a malposition of the left upper canine. She had a previous orthodontic treatment; therefore, she was wearing fixed retention from the upper right to the upper left canine. Her upper right central incisor and lateral incisors were restored by ceramic veneers, whereas on the upper left central incisor a porcelain fused to metal crown was in place (Fig. 1).

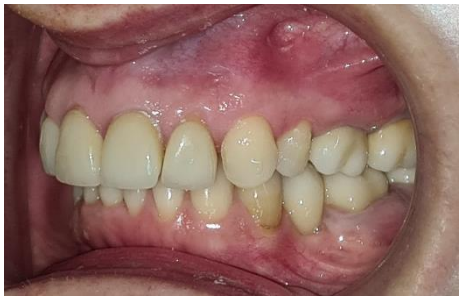

**Figure 1. Initial situation.**

Due to an increased nausea and fear of veneers deboning, the patient refused conventional impression techniques as well as removing the initial maxillary fixed retainer. After clinical and paraclinical examination, a digital workflow was proposed.

The workflow comprised the following phases: intraoral scanning of the maxilla and the mandible, visualization of the dental arches on a monitor, occlusion analysis, design of a virtual treatment plan, design of the oral splints (aligners) using CAD technology, acquiring the aligners by the vacuum thermoforming approach, with the aid of printed 3D casts.

Intraoral scanning was accomplished using a 3Shape intraoral scanner (Cerec, Sirona, Germany) [6], without removing the upper fixed retainer, the resulting Standard Triangulation Language (STL) file being transmitted through the internet to the dental technician, and a rendering of the images was done using a the software 3Shape orthodontic planner software [7] (Fig. 2).

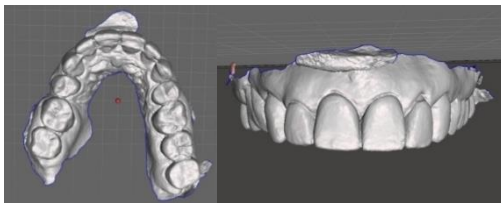

**Figure 2. Intraoral scanning of the maxillary arch.**

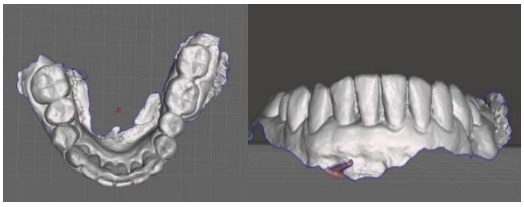

**Figure 2. Intraoral scanning of the mandible.**

CAD/CAM technology was used to create a virtual treatment plan, which was done without considering the existing retention. The orthodontic treatment plan was designed in the dental laboratory by an experienced orthodontist and a trained technician.

The patient was shown the scanned arches before treatment, as well as a virtual treatment plan simulation (Fig. 3, 4).

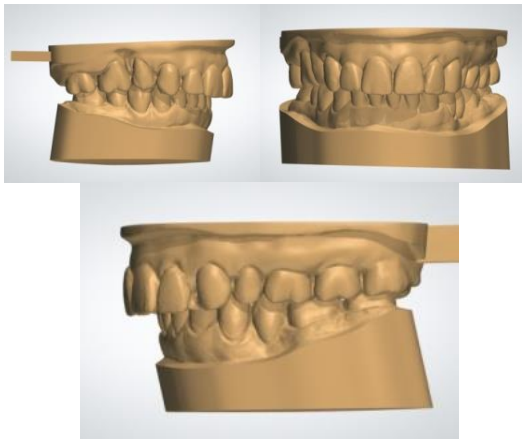

**Figure 3. Scanned arches before treatment.**

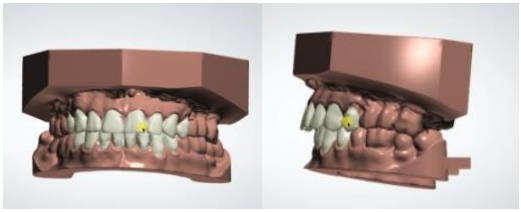

**Figure 4. Virtual treatment planning.**

The occlusion analysis was performed virtually (Fig. 5) in order to establish the amount of possible tooth movements, torque, antero-posterior relationships between the arches and the final result.

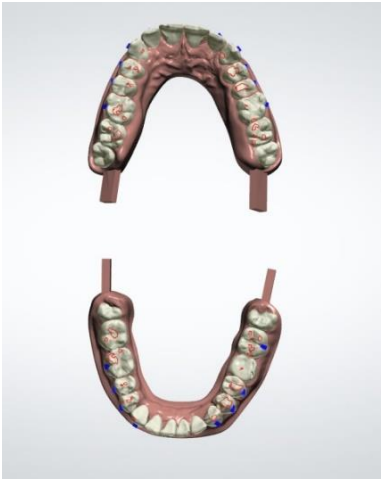

**Figure 5. Occlusion analysis.**

A virtual representation of the orthodontic treatment plan was created and shown to the patient (Fig. 6). The proposed plan comprised a "guide" splint for buttons placement and four active orthodontic splints (aligners). Before and after images of the simulated design were available.

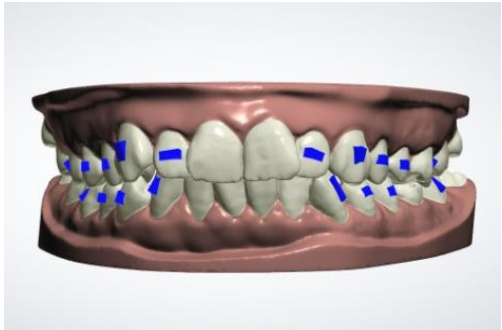

**Figure 6. Virtual set-up of the tooth movements.**

Following the patient's approval of the protocol, a set of five printed models for five splints were constructed.

These were realized on 3D printed models, using a Photocentric® 3D printer (Photocentric Ltd, Peterborough, UK) [8]. The pressure moulding technique was applied for splint construction, by the support of a Ministar S® machine (SCHEU-DENTAL GmbH, Iserlohn, Germany) [9]. The planned buttons for initiating tooth movements were transferred to the dental arch using a "guide" splint (Fig. 7).

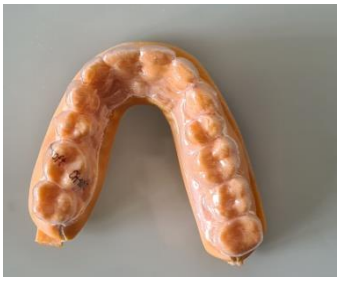

**Figure 7. The "guide" splint for buttons transfer, customized on the printed cast.**

Buttons of different shapes and dimensions, with particular effect, were placed on various teeth (upper right first premolar, upper left canine, upper left first premolar) to aid in tooth movement. These were constructed from flowable composite (Brilliant Flow, Coltene), which was inserted into the "guide" splint and polymerized through the splint (Fig. 8 a, b).

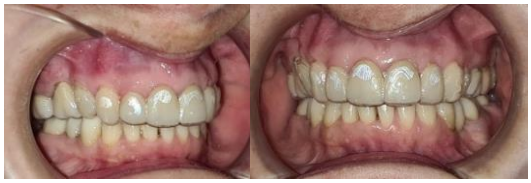

**Figure 8. a. Right lateral and frontal view of the "guide" splint.**

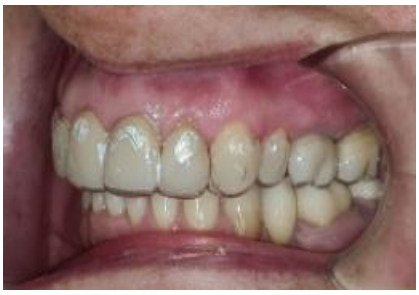

**Figure 8.b. The "guide" splint performed by the CAD/CAM technology, along with the composite buttons, applied intraorally, left lateral view.**

After the bonding of the buttons, the initial fixed retainer was removed, for tooth movement to be achievable, and the first orthodontic splint (aligner) was applied, the patient being instructed to wear it for a period of two weeks. In total, four active aligners were used. Upon the active orthodontic treatment, the space between the upper left lateral incisor and the canine was closed, the axis of the canine was corrected, and a space of 1.5 mm resulted distally to the canine, which was closed by a porcelain veneer, performed on the upper first premolar (Fig. 9).

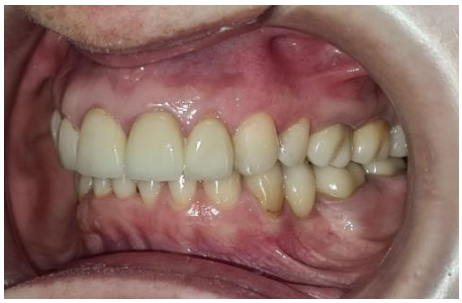

**Figure 9. Final treatment result.**

Following prosthetic treatment, a new fixed maxillary retainer was applied from canine to canine. For increasing retention, another intraoral scanning was performed, for the execution of a retention splint, using the same technology.

## RESULTS AND DISCUSSIONS

This case was treated orthodontically for minor tooth correction using the computer-aided workflow. Five splints were required: one "guide" splint for button placement and four active splints for tooth movements. Every active splint was meant to be worn for two weeks, uninterrupted, except for eating and teeth brushing. The second splint was applied after the previous one has already been worn for two weeks. The third splint was applied and fit properly because the patient had worn the prior two splints as instructed.

Because the third splint was not worn all of the time due to personal reasons, the fourth splint did not fit well after two weeks. Another week of wearing of the third splint was indicated. The fourth splint fit perfectly afterwards, and the treatment plan progressed as expected.

The proposed virtual treatment plan was also carried out in practice with the use of orthodontic splints, alike with the digital project.

This case report illustrates the treatment plan using CAD/CAM and 3D printing technology, as also suggested by Pillai *et al*., 2021 [10]. The digital technology offered increased benefits for both, the patient, and the practitioner. The patient was provided with a comfortable impression technique and an increased precision of the oral splints, whereas for the practitioner it was a neat and convenient method.

Patzelt et al., 2022, have described that the overall fit of the digitally-fabricated splints was increased when compared to conventionally-fabricated splints [4], which we have also experienced.

Digital technology can be used in orthodontics for virtual treatment planning, tooth movement simulations, occlusion analysis. Venezia *et al*. 2019, have shown that splint realization using digital technology is

highly accurate and precise, being laboratory more convenient, and in case of need might be duplicated due to the digital file provided by the CAD technology [11]. We have also experienced a positive feed-back from the technician as well as from the patient, the digital workflow being less time consuming.

The future directions of splint manufacturing are aiming towards digital workflow technologies. In this aspect, Marcel *et al*. 2020, have studied the difference of accuracy of CAD/CAM-fabricated bite splints between milling and 3D printing and have shown that milled splints had a higher degree of accuracy than 3D-printed splints, although the 3D printed had a wide range of reproducibility [12].

Despite all of the advantages of the digital workflow, it is still modestly used by practitioners due to the equipment' high costs [3] and due to the learning curve. Taking the leap into digital technology necessitates significant spatial vision on behalf of the practitioner and a steep learning curve on behalf of the technician.

Enhanced communication with the patient and efficient interdisciplinary teamwork was achieved in the above presented case, numerous specialists being involved in the treatment plan: estheticians, an orthodontist, prosthodontists, and dental technicians, leading to an improvement in design and implementation of the treatment plan.

Yet even with significant benefits, education and practice is needed to embrace the widespread of digital models and virtual setups in dentistry [13]. However, practitioners could be a little confused, as also stated by Vandenberghe B. 2020, due the contradictory findings on the accuracy of virtual treatments that the literature frequently presents, and also by the numerous technologies of the digital workflow [14]. Nevertheless, the multidisciplinary approach using digital therapeutic prediction enables the process of informed decision prior to performing challenging complex rehabilitations [15] stays true.

## CONCLUSIONS

1. The digital workflow for creating occlusal splints saved clinical time and improved treatment efficiency.
2. Patient compliance using digital technology was increased, performing an intraoral scan was easier than getting a traditional impression or undergoing orthodontic treatment using brackets.
3. For minor tooth movements in adult patients, computer-aided workflow can be implemented, with positive results.
4. Both the practitioner and the technician should step beyond their comfort zones to adapt to the new learning curve that the new technology entails.

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**Informed Consent Statement**

Written informed consent for publication has been obtained from the patient to publish this paper.

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