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Research Article

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Workflow in Digital Full Dentures

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Abstract

In the era of new technologies, the workflow in the department of removable prosthodontics has undergone several changes resulting in the reduction of working time in the laboratory, the reduction in the number of sessions spent on the chair, and the reduction in the overall cost of the complete dentures. This work aims to demonstrate, through a clinical case, the computer-aided design and manufacturing steps as well as the difference between the two workflows adopted during the production of two complete dentures at the department of removable prostheses. of the dental consultation and treatment center (D.C.T.C) of Casablanca.

Keywords: CAD-CAM(Computer Aided-Design Computer-Aided Manufacturing), Full Dentures, Functional Impressions

1. Introduction

We are currently witnessing one of the greatest revolutions in dentistry. Although still new, these CAD/CAM technologies already produce clinical results at least equivalent, if not better, than traditional techniques. They represent a considerable time saving for the laboratory technician while ensuring a limitation of inter-operator bias. From a medico-legal, as well as a practical point of view, the digital preservation of patient impressions and prostheses also represents an organizational advance; The loss, fracture, or deterioration of a removable denture no longer represents the fatality of a return to zero of the clinical and laboratory stages. With the precision of digital tools are constantly evolving and the processes always being improved, we can only be optimistic about the future of these technologies, even beyond removable prostheses.

2. Materials And Methods

2.1. Clinical Examination

Mr. BJ, aged 70, presented for consultation at the department of removable prosthesis. of the dental consultation and treatment center (D.C.T.C) of Casablanca; to benefit from a complete bi-maxillary prosthetic rehabilitation, the patient was never fitted before. The intraoral examination shows that the two arches have sufficient volume and height, covered with thick and adherent fibro mucosa, corresponding to Sangiuolo class I (Figure 1). The occlusal examination highlights an occlusal class I, it also shows that the prosthetic space available is sufficient in the three directions of space (Figure 2).

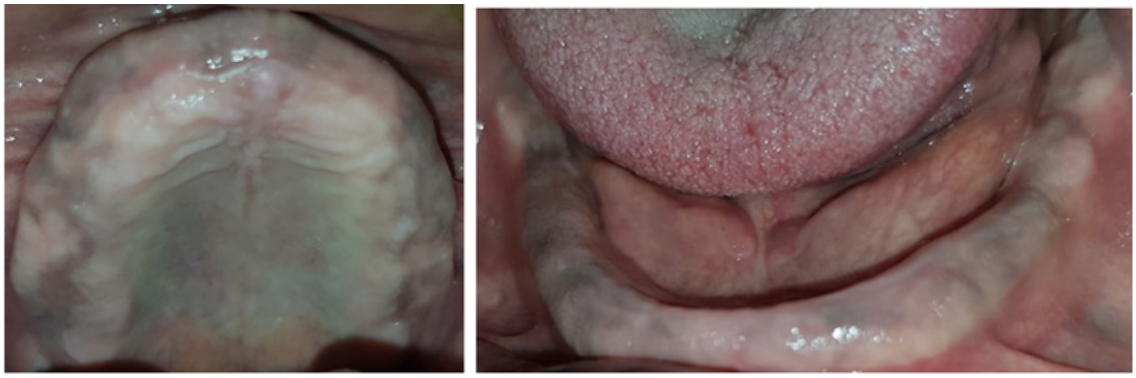


Figure 1: Intra-Oral Examination

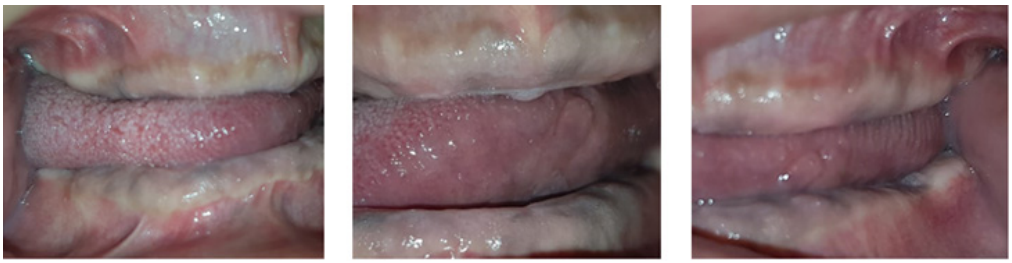


Figure 2: Occlusal Examination

2.2. Primary Impressions

The primary impressions were taken with plaster (Snow white®) using commercial impression trays, after their decontamination, they were sent to the C.C.T.C laboratory; On the models resulting from this casting, individuals trays in self-curing resin were made (Figure 3).

Figure 3: Bi-maxillary Primary Impressions and Creation of Individuals Trays

2.3. Functional Secondary Impressions

The complete peripheral seal was saved by border molding using a thermoplastic paste (Kerr® paste), the final impression was then carried out using a medium-viscosity polysulphide (Permlastic Regular®) (Figure 4).

Figure 4: Permlastic Regular® Secondary Impressions

2.4. RIMs Recording

From the secondary models obtained following the classic casting of the functional impressions, we made wax occlusion models; The maxillary pad was adjusted in harmony with good labial support, then the adjustment of the occlusion plane was conducted conventionally using a Fox plane. After adjusting the vertical dimension of occlusion, we recorded the centric relation with the "Aluwax" wax (Figure 5). These intermaxillary relationships were digitized by the "MEDIT I 500" intraoral scanner.

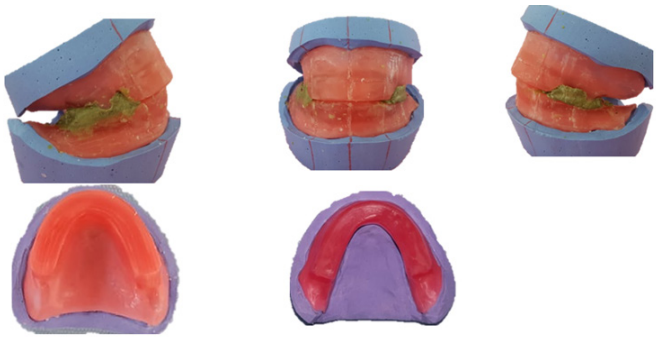


Figure 5: Wax Bite Models and Registered RIMs (Aluwax Wax)

2.5. Computer-Aided Design of the Dentures (Blue Sky Bio® Software)

2.5.1. Importing Secondary Models and Base Plate Bite RIMs

The software requires several points to be specified to correctly position the models:

- the concerned arch (maxillary or mandibular)
- the nature of the arch (toothed or edentulous, total or partial)

Then we have to mark three anatomical landmarks specific to each arch: in the maxilla, we will mark the location of the two pterygomaxillary ligaments and the retro-incisor papilla, while in the mandible the most posterior part of the trigones and the median brake are the referenced points. The software offers the possibility of correcting the three-dimensional orientation of the secondary cast to ensure perfect positioning.

2.5.2. Occlusion of the Two Secondary Models

Before digitizing them, we engraved 4 notches on each side on the entablatures of the secondary models, these marks not only acted as markers during the digitization of the models facilitating and fluidifying the optical impression but they were also used during the design to ensure the alignment of the two STL files acquired (Figure 6).

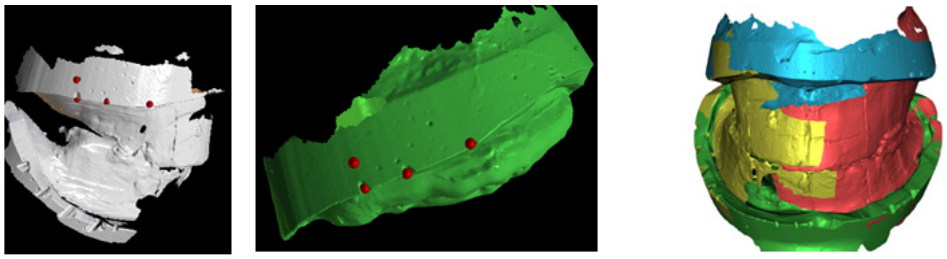


Figure 6: Alignment of the Occlusion Models on The Secondary Models Using The Reference Notches (Blue Sky Bio®)

2.5.3. Teeth Selection and Mounting

When recording the RIMs, we marked on the maxillary base plate bite rim the level of the upper lip when smiling, the median sagittal axis and the extension of the wings of the nose corresponding to the extension of the tips canines; the choice of the shade is an important element when choosing the teeth, it is expressed during the manufacture during the choice of the impression material. In this case, we have chosen a complete set of medium-sized bi-maxillary teeth from the "BRENES SQUARED" virtual teeth library, although the teeth have been positioned in occlusion, in the vertical direction, the incisor edges and the maxillary occlusal tables corresponded to the occlusal plane, while in the frontal plane the teeth were mounted according to the labial support chosen during the adjustment of the anterior projection of the maxillary base plate bite rim (Figure 7).

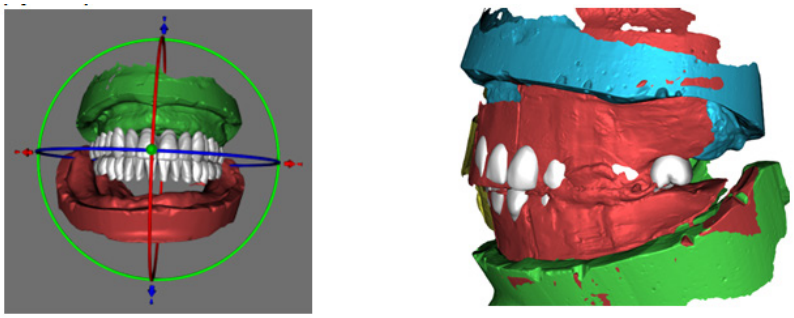


Figure 7: Virtual Teeth Mounting(Blue Sky Bio®)

2.5.4. Choice of Insertion's Axis

The choice of the axis of insertion was carried out as described previously, making it possible to create a plinth in the extension of the entablature (Figure 8).

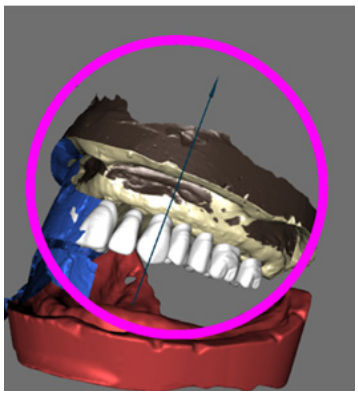


Figure 8: Choice of Prosthetic Insertion Axis

2.5.5. Drawing of the Prosthetic Limits and Finishes

The drawing of the prosthetic limits was carried out identically to the classic protocol: 1.5mm from the bottom of the vestibule and 2mm from the brake insertions, then using the tools provided by the software, we sculpted the prosthetic bases.

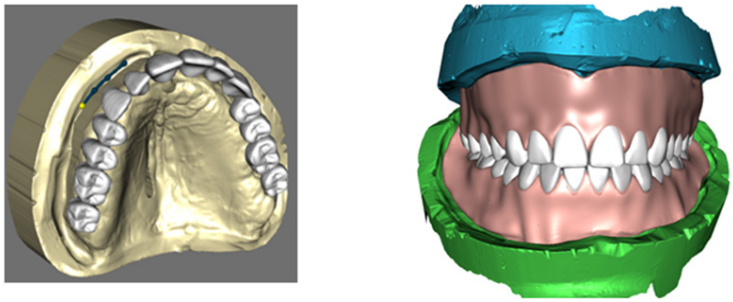


Figure 9: Layout of The Prosthetic Limits and Rendering of The Complete Bimaxillary Prostheses After Finishing

2.5.6. Exports of the Different Surfaces to be Printed

In this case, we exported 4 surfaces:

Two alveolus prosthetic bases and two chains of connected teeth; The assembly of the teeth with the prosthetic base will be done using flow composite resin.

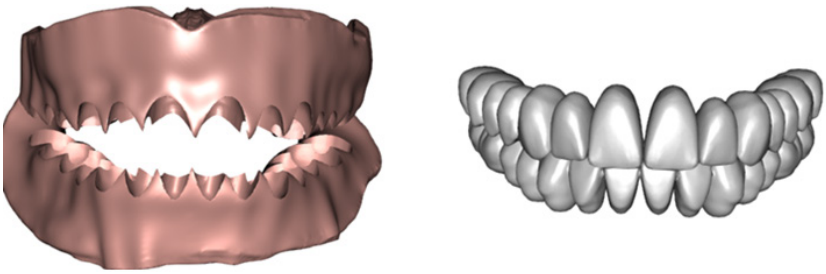


Figure 10: Export of Two Different Types of Surfaces (Prosthetic Bases And Connected Teeth)

3. Results

3.1. Computer-Aided Manufacturing of the Complete Dentures

The impression of the alveolus prosthetic bases was carried out using the resin “Dentona optiprint Denture” while the impression of the connected teeth was carried out using the resin “Dentona optiprint crowns”.

3.1.1. Preparation for Printing the Alvelus Prosthetic Bases

The preparation for printing the prosthetic bases was carried out using the "Composer" software provided by the "ASIGA Max" printer, after adjusting the thickness of the layers of printing at 25µm and the pixel resolution at 1920x1080, we have added support rods to the intrados. Finally, the estimated construction time for the maxillary prosthetic base is 5 hours 26 minutes and 16 seconds, and 5 hours 22 minutes and 49 seconds for the mandibular prosthetic base (Figure 11).

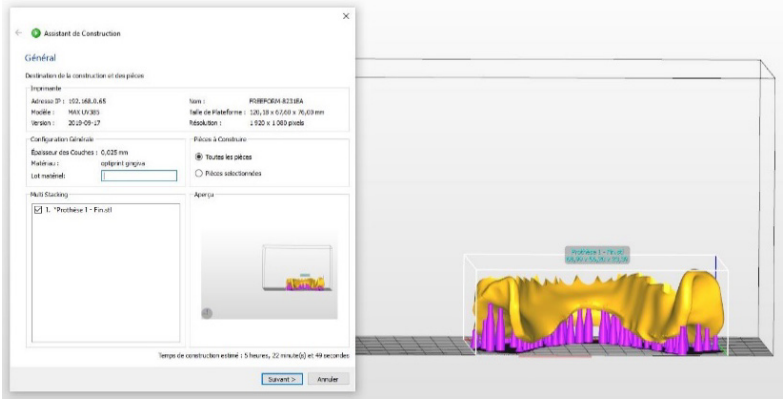


Figure 11: Preparation of The Prosthetic Bases For Printing

3.1.2. Preparation for the Impression of the Prosthetic Teeth

Identically to the prosthetic bases, support rods were placed at the level of the heels of the connected teeth so as not to affect the anatomy of the occlusal surfaces.

The estimated impression time of the two dental chains is 42 minutes and 46 seconds (Figure 12).

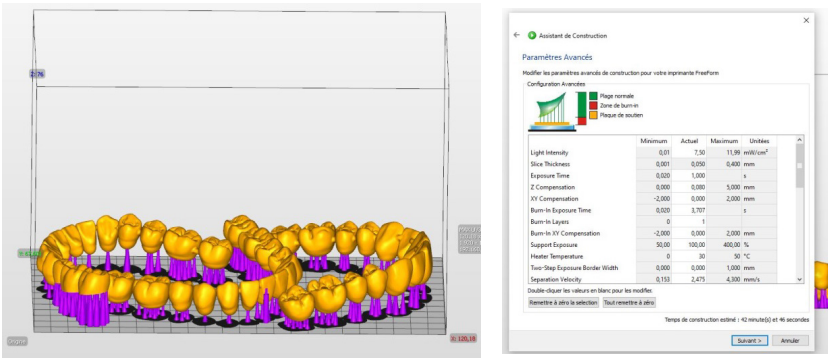


Figure 12: Preparation of Dental Chains for Printing

3.1.3. Teeth/Prosthetic Base Assembly

Once the computer-aided manufacturing was complete, we first immersed the bases and teeth in an isopropyl alcohol bath to remove excess monomer, then proceeded to manually remove the support rods prosthetic bases and teeth, followed by the trial of passive insertion of the teeth to the bases. Finally, the finishing was carried out using a pink stone cutter mounted on a handpiece to eliminate surface irregularities, followed by polishing with a pumice stone.

The assembly of the teeth to the prosthetic bases was carried out as follows:

Application of 3M Auto-bond self-etching adhesive on the heels of the teeth and in the sockets of the prosthetic bases (Figure 13).

- Light curing for 40 seconds (Figure 14)
- Application of the resin "Dontona Denture" at the level of the alveoli
- Placement of teeth and removal of excess resin
- Light curing for 40 seconds per tooth.

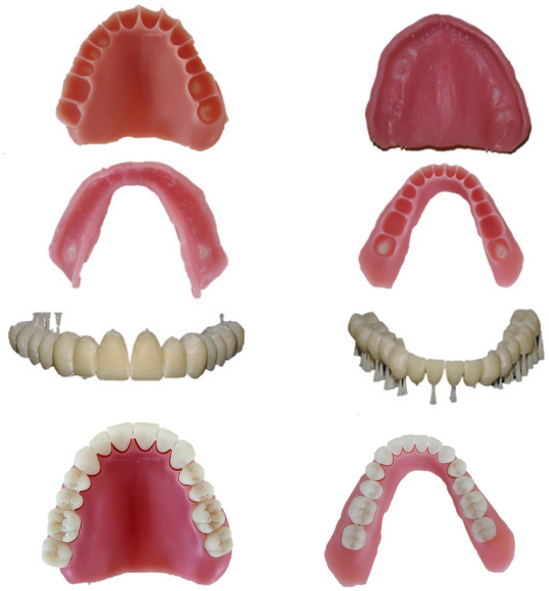


Figure 13: Alveolus Prosthetic Bases and Printed Teeth

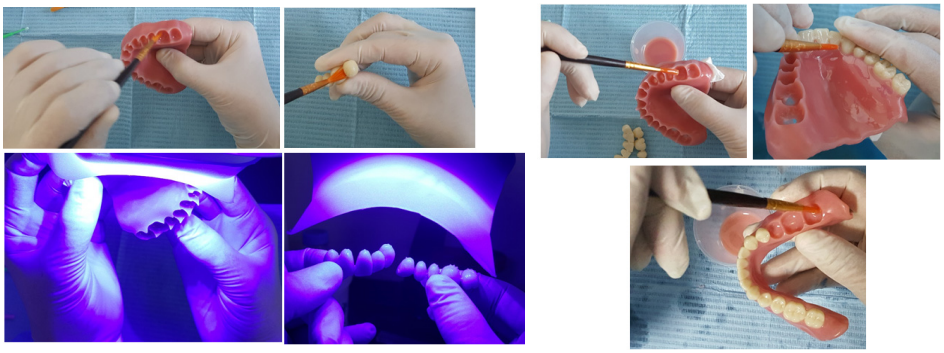


Figure 14: Prosthetic Bases and Teeth Assembly

3.1.4. Post-Treatment and Finishing

Post-treatment consists of placing the assembled dentures in a tank fitted with a 12 W UV lamp for 1 hour to complete the photopolymerization of the bonding resin; As for the finishing, it consists of applying the "OPTIGLAZE" surface resin to both the internal and the external surface of the dentures, followed by light-curing for 60 seconds (Figure 15).

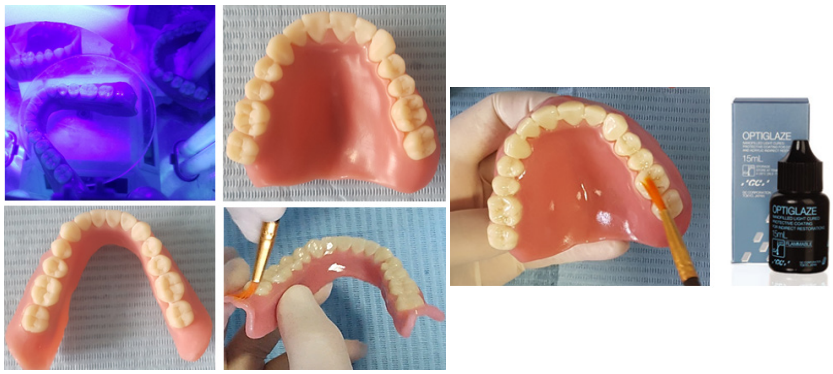


Figure 15: Dentures Post-Treatment and Finishing

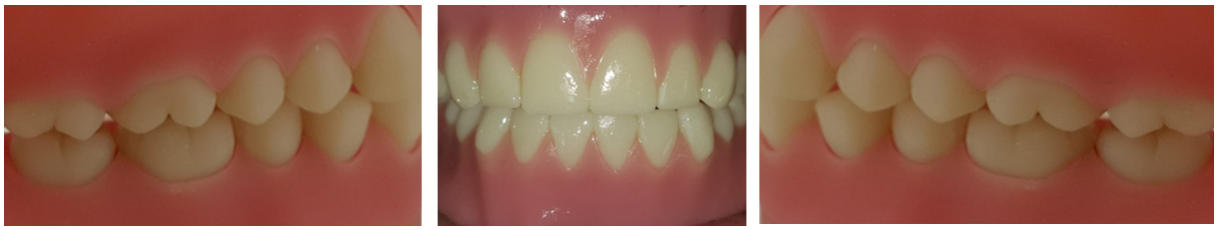


Figure 16: Insertion of the Digital Complete Dentures

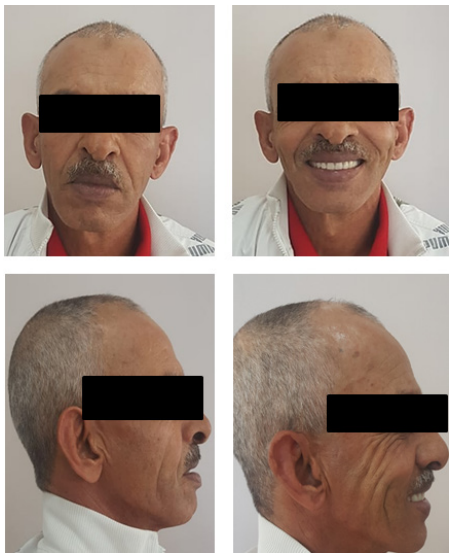


Figure 17: Front and Side Photographs of The Patient Before and After Placing The Complete Digital Dentures

4. Discussion

A) The Presence of Residual Monomer in CAD-CAM full Dentures

The presence of free methacrylate monomer in the prosthetic bases hinders the mechanical properties of the resin and also compromises the biocompatibility of the printed prosthesis; Unfortunately, some residual monomer is unavoidable due to the monomer-polymer balance necessary for free radical polymerization of denture base resins. In addition to influencing the mechanical properties of the resin, the residual monomer also infiltrates the surrounding tissues and saliva, it is incriminated in several allergic or cytotoxic reactions related to the prosthetic bases; The resulting symptoms vary from simple mouth burning sensations, ulceration, and stomatitis to generalized edema. The use of high pressure and temperature, for the manufacture of PMMA to manufacture digital dentures, contributes to the development of longer polymer chains compared to the conventional PMMA of self-curing resins, which results in a higher degree of monomer conversion, less porosity, and reduced free volume.

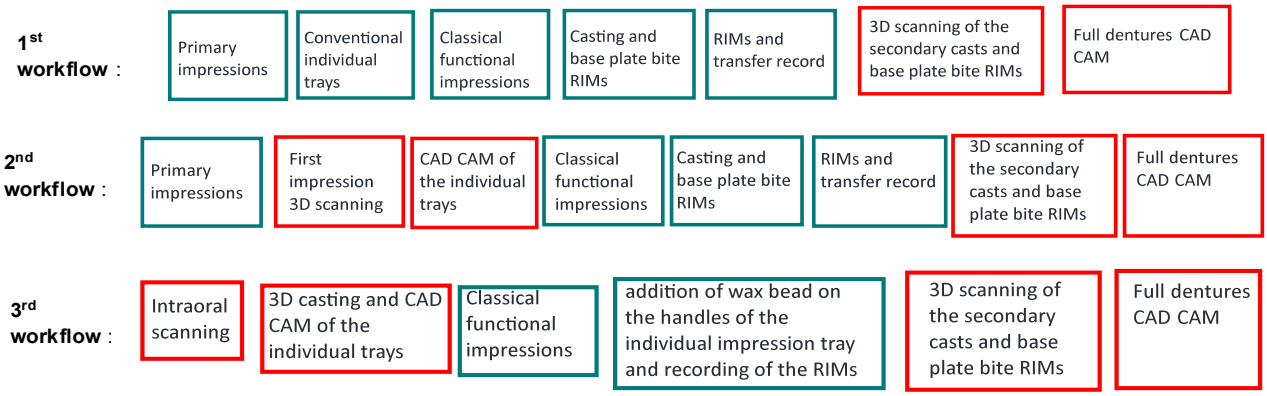
By comparing the monomer content in conventional PMMA to the one used for 3D printing removable prostheses, Ayman

concluded that the latter has the lowest residual monomer content, he also concluded that these results are attributable to the pre-polymerization under the pressure of these PMMA resins. Indeed, pre-polymerization under high pressure favors the formation of longer polymer chains and therefore leads to a higher degree of monomer conversion with lower values of residual monomer [1]. On the other hand, the study by Steinmassl et al., (2017) compared the release of monomer between four different types of digital PMMA with one type of conventional PMMA; They concluded that all of the dentures evaluated released very low amounts of monomer and found no statistically significant correlation between monomer release and prosthesis weight, density, or surface area [2]. They believe that the presence of the monomer is either due to the bonding agent used to secure the fabricated teeth to the dimpled prosthetic bases or to the thickness of the pre-cured disc which prevents evaporation of the monomer from its inner core during milling.

B) Adhesion of the Teeth to The Prosthetic Bases

Panagiotis et al., (2013) reported that if the adhesive is applied followed by the PMMA resin monomer, it acts as a sealant rather than a primer thus increasing the chemical adhesion of the teeth to the bases [3].

The incorporation of computer-assisted steps during the design of complete dentures can take place at different stages so several digitized workflows can be proposed as shown in the following diagram:



C) Chair time Analysis

The average number of clinical shifts necessary for the realization of conventional complete dentures by dental students exceeds 5, however during this study, this workflow was replaced by a digital flow composed of 4 clinical shifts, the impact economic inherent in the reduction of the number of visits and appointments management of complaints is minimal compared to that generated by the internal denture's manufacture without sending them to an external laboratory The authors believe that the number of sessions devoted to the management of post-prosthetic complaints is reduced thanks to the good adjustment and the occlusal pre-equilibration carried out at the software level.

5. Conclusion

Virtual articulators combined with functional three-dimensional modeling of the temporomandibular joint in addition to 3D imaging and facial scanning allow better management of the patient's real anatomy to rehabilitate a balanced occlusion respecting the functioning of the temporomandibular joints without segregating it from the overall aesthetics of the patient's face. It is nevertheless advisable to remain objective in the face of this transition which brings with it its share of constraints, indeed, the equipment acquisition and materials costs inherent to these technologies, as well as the consequent duration of development the learning curve allowing all operators (dentists and laboratory technicians) to acquire ease of use. The transition from analog to digital in a complete prosthesis can take place at any stage of the workflow, however, it cannot be exempted from the functional impression. Indeed, and given its functional recording of the para-prosthetic organ's movements, only the conventional method makes it possible to achieve this objective; Looking to future possibilities, it is not fanciful to imagine that in a few years we will witness the development of new add-one or software allowing the correct digitization of this impression.

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