

Egyptian Prosthodontic Association (EPA Newsletter)

Digitizing full mouth rehabilitation cases



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The introduction and continuous development of modern technologies in dentistry has drastically improved the final restorative outcome especially in full mouth rehabilitation cases. CAD/CAM devices and software and even more recent technologies have facilitated the change and enhancement of the full mouth workflow to be easier, predictable and reproducible almost in all cases, removing the setbacks of the conventional analogue workflow that's hugely affected by the materials related problems and the variance in the dentist and/or technician individual skills and knowledge.¹

We have explained in a previous newsletter a simplified but thorough traditional workflow for these complicated cases. In this episode we will go through the present digital dental solutions that can totally replace, or integrated with the previous workflow.

I- patient's records:

a) Digital impressions: with the increased popularity of CAD/CAM technology, the production of digital study models became more or less a daily routine in our practice either by digitizing the conventional stone models (desktop scanners) or by taking direct digital impressions using intra-oral scanners. Needless to say, the digital impressions are much easier, reproducible, more productive, and the main advantage is the direct incorporation of the patient's interocclusal or bite records automatically with both models.² (Figure (1) a-d).

b) Virtual articulator (VA): in the conventional workflow, we have to simulate the mandibular movements made by the patient to identify the interferences that need to be adjusted and produce a harmonious dynamic occlusion.

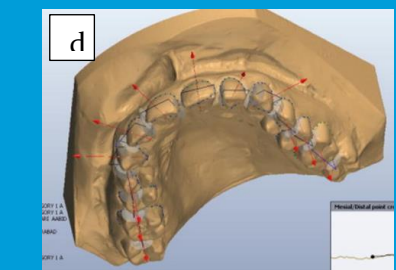


Figure (1): a) intraoral scanner. b) desktop scanner. c) intraoral digital model. d) extraoral digital

So, the models are mounted on a semi or fully-adjustable articulator as previously explained. In the digital world, a virtual articulator was invented and incorporated into the CAD designing software, having exact virtual copies of most of the mechanical articulators to choose from and facilitating the use of the digital models to adjust the movements and optimize the occlusion. This can be done in two ways³:

i) indirect method: by scanning the articulator using a desktop scanner and transferring the files to the VA, or by transferring the readings (condylar path angle, anterior guidance angle, Bennett angle and movements ...etc.) on the original articulator manually to the software. (Figure 2)

ii) direct method (digital method) : which depends on the creation of a virtual facebow (VF) and its superimposition with the previously made digital models and bite records, then using the data to mount the virtual articulator on the CAD software. The virtual facebow simply is a method to orient the upper and lower arches of the patient to a reference plane (e.g. FH plane, camper plane, occlusal plane, incisal plane) from the patient's head.

A handful of methods were suggested in the literature throughout the years to create the VF including digital cephalometries, 3d optical scanners, digital photography, stereophotogrammetry, CBCT or a combination of any of these methods. The most recent and accurate method employs the use of 3D face scanners, which is a device with multiple cameras with high resolution that can capture the patient's head in multiple positions and poses to create real 3D model of the patient that can be exported in any of the known formats (STL,PLY,OBJ) to the CAD software and be easily superimposed to the patient's digital models to mount the virtual articulator.^{1,4} (Figure 3)

The whole workflow for virtual articulator is explained by the diagram in (Figure 4). You have to pay attention that all the previously mentioned methods didn't record the real and full mandibular movement of the patient but rather simulating it by capturing the beginning and the end of the movements using protrusive and lateral excursive records to mount the articulator and using mathematical equations to create the rest of the movements. (Mathematically calculated VA).

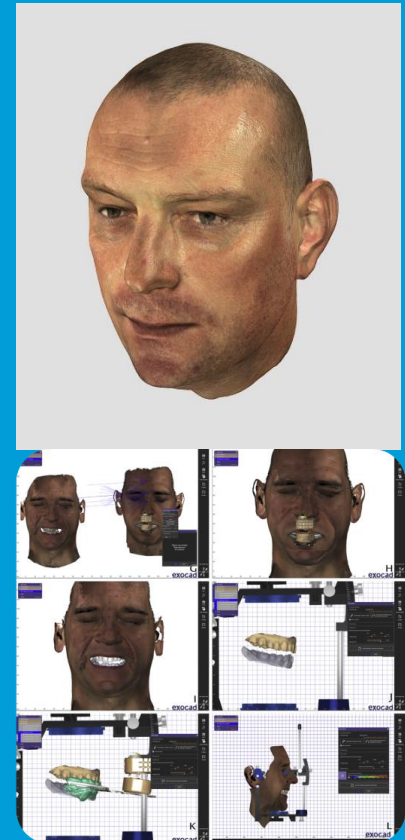


Figure (3) : direct method for VA using face scans and its superimposition with digital

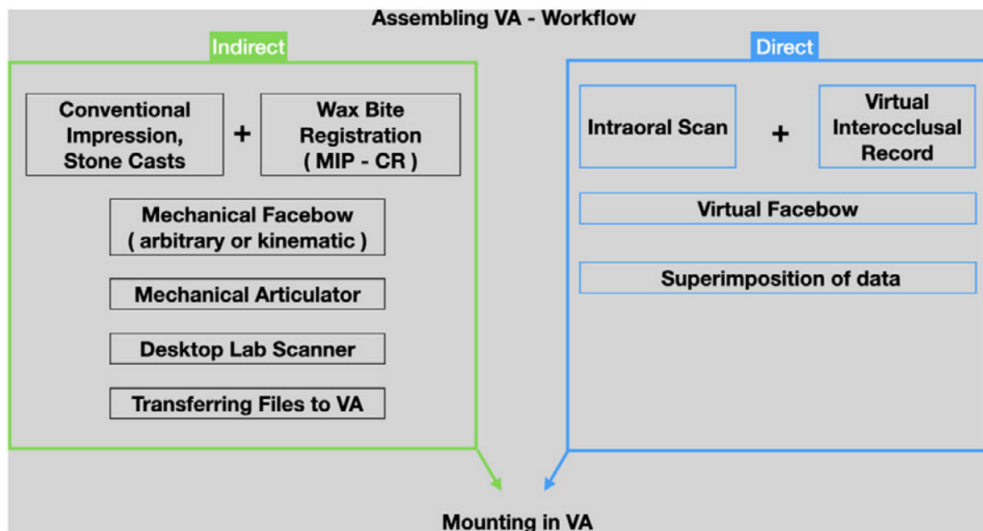


Figure (4): The whole workflow for VA

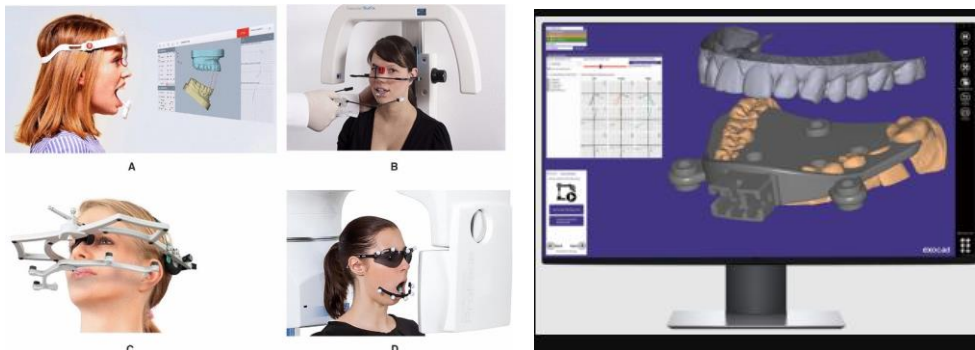


Figure (5): Jaw motion analyzer

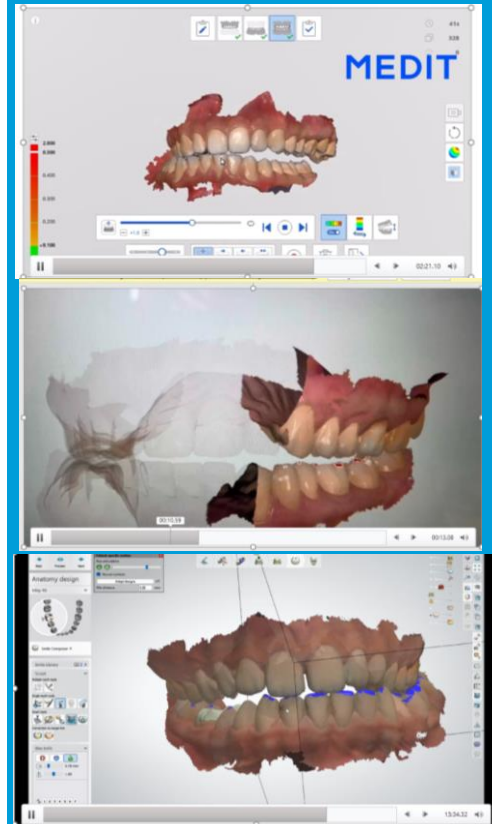


Figure (6) : Motion scans in intra oral scanners

In the analog workflow, recording the exact actual mandibular movements needed the use of highly sophisticated devices (condylographs and fully adjustable articulator) and the high operator skills and experiences with these tools to obtain accurate records. So, most of the dentists throughout the world primarily depended on the mathematically calculated methods. Recently, jaw motion analyzers were introduced in the market which solved the dilemma of recording the patient's actual movements.

c) Jaw motion analyzers: these are motion recording devices (e.g. Zebris JMA, MODJAW) using high resolution cameras and electronic jaw trackers that can record the real live patient's motions into a video that can be exported as a XML file format to the CAD software to create what is called a completely adjusted VA (CA virtual articulator). These devices are beneficial for obtaining the real patient's facebow, terminal hinge axis, accurate condylar-incisal and Bennett angles, envelopes of motion and function. When transferred to the CAD software

they automatically override the virtual articulator where you can diagnose, plan and design the restorations according to the patient's specific occlusion.^{1,4} (Figure 5).

However, jaw motion analyzers are still too expensive to be used in everyday clinical practice. It's interesting to know that some intraoral scanners available in the market (e.g. 3Shape, Medit) have developed a specific motion scans feature that enables the dentist to record the mandibular movements after acquiring the intraoral and bite scans. However, these records are still restricted to the company's specific CAD software. (Figure 6)

II- Digital smile designing (DSD) and virtual waxing up:

Another benefit of the CAD/CAM technology is the ability to digitally design the patients' smile and the final restorations later on using the digital photographic records, videos and digital models that would be imported on the CAD software. the digital design can be used to produce a virtual wax up of the proposed design that can be 3D printed into a physical model for a real mockup inside the patient's mouth² (Figure 7)

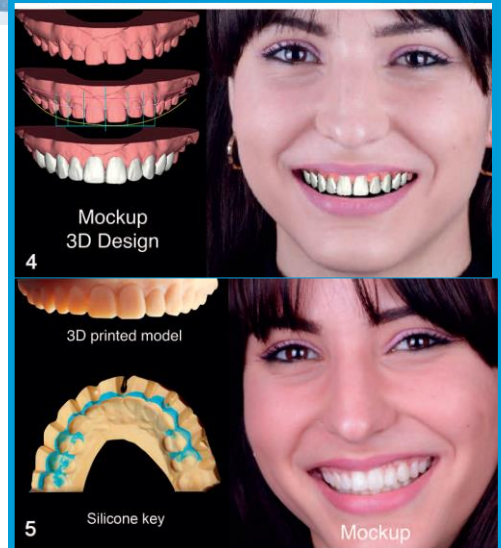


Figure (7): DSD, Virtual wax up and mockup

III- Occlusal adjustment and Equilibration:

which is a very important step whether in the planning phase or the restorative phase as explained in the last newsletter. In the conventional workflow, this step was done on the models and the wax-ups at first then on the fabricated restorations finally and it employed the use of articulating papers and shim stock foils. It was totally dependent on the operator and the technician's knowledge of the interference positions and amounts to be adjusted. Alternative digital occlusion detection devices are now available in the market (e.g. T-SCAN , Occlusense) that consist of an electronic pressurized sensor fork that can be introduced in the patient's mouth to bite on, and it can record the exact amount and location of the interferences and even record a live video to identify the point of initial contact, to be demonstrated on a computer screen, and can be imported to the CAD software to aid in optimizing the occlusion whether in the wax-ups or the final restorations ²(Figure 8).

Conclusion: in the era of digital dentistry, handling and treating full-mouth rehabilitation cases became much easier, reproducible and successful by either integrating the various digital tools in the analogous workflow or adopting a complete digital workflow as shown in (Figure 9)

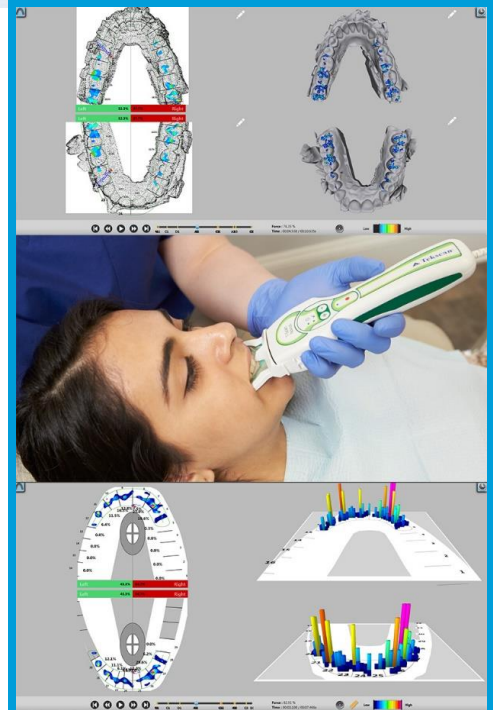


Figure (8): T-scan



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