Using digital techniques to increase the efficiency and control of orthodontic procedures: a case study

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Taking impressions with trays and PVS silicone, shipping them, producing study models, and archiving models to facilitate the orthodontic practice—these long and sometimes tedious work steps have always been readily accepted by most orthodontists as unavoidable aspects of the job.

Since the introduction of high-performance intraoral scanners for taking digital impressions, these steps are no longer necessary: shipping impressions and editing physical models is eliminated in most situations.

Instead, digital impressions can be created faster by way of a three-dimensional (3D) scanner, and the resulting files can be transmitted immediately and with ease.

These files are used as a basis for the diagnosis and planning of digital orthodontic treatment (CAD) and, increasingly, to produce fixed and removable orthodontic appliances (CAD/CAM).

However, there are greater possibilities! The virtual information obtained from intraoral impressions provides us with new means of evaluating and optimizing treatment, which we shall present here.

STARTING WITH FIXED ORTHODONTICS

In November 2014, at the age 28 years, this patient visited our office with joint and muscular disorders (clicking and pain in the right temporomandibular joint). An extraoral clinical examination revealed a mandibular deviation to the right (Fig. 1).
During the intraoral examination, additional dysmorphoses were detected. The shape of the dental arch, the canine axes, and the Wilson curve showed asymmetries (upper right maxillary linguoversion). The maxillary incisors showed significant overcrowding. An inversion of the right molar joint was observed (Figs. 2–7). A lower midline deviation was clearly visible on the frontal face X-ray (Fig. 8). Several treatment options are proposed to such
patients who opt for an individualized lingual treatment on the maxilla. On the mandible, a fixed vestibular treatment was planned.

On the virtual 3D cast, the dental arches and arch shape was simulated to visualize the asymmetries of the axes and arches (Figs. 9, 10).

All these dysmorphoses can also be analyzed on exported digital casts (STL files) or in real time on the touch screen of the 3M™ intraoral True Definition Scanner.

A frontal X-ray shows the deviation from the mandible against the median sagittal axis. Occlusal plane tilt.

Figure 7

The dental axes can be traced to visualize the asymmetries.

Figure 9

The dental axes and arch were plotted to view the asymmetries.

Figure 10
ONLINE PRESCRIPTION

This was done after the digitization of the patient’s arches and establishing the diagnosis.

Because the patient chose lingual maxillary treatment, we used the Unitek™ software; Treatment Management Portal (TMP), for Incognito 3M.

Thus, we filled out an online order form on this software. This prescription allowed users to inform the laboratory about the condition of their teeth, the desired median positions, the shape and width of the dental arch, etc (Fig. 11). The values and ratios of the molars and canines were specified. In addition, the different types of brackets, the auxiliary parts (in this case Ricketts scissors for ATP), and the arcs were selected for the maxillary device (Fig. 12).

This “online” procedure was carried out by filling out some forms on the screen, and it takes only a few minutes for someone who is familiar with it.

Figure 11
Treatment plan prescription and order of individualized locks on TMP
Before digital recording of the arches, the conventional plaster models of malocclusion were produced from VPS impressions, and they were digitized with an industrial scanner.

Today, these steps are eliminated with the introduction of intraoral digital impressions.

Th digital files are directly downloaded to TMP. With the treatment plan ordered online by the orthodontist, these files are simply imported into the digital setup software “SetUp Lab” (DSL).

The setup can be ordered online for both arches, even if the mandibular arch is planned to be treated via a conventional vestibular technique, as was the case in our patient. The technician creates this digital setup and uses TMP to send it to the practitioner for verification.

Figures 13 and 14 show that it is possible to view the models of occlusion and setup separately or together in the “overview” mode (Figs. 13, 14).

In addition, these models can be manipulated in all the spatial planes and measurements can be made.

For example, intermolar and intercanine distances can be measured and compared for tracking displacements. Communication is facilitated by the notes, which allow laboratory technicians and orthodontists to place annotations at selected reference points if and when corrections are necessary.

**Figure 12**
Order summary for brackets and locks to be used on the maxillary arch.
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**Figure 13**
Setup with notes made by the technicians in the 3M lab.

**Figure 14**
Setup verification in overlay on the malocclusion model in the TMP software.
INDIVIDUALIZED PRODUCTION OF THE MEDICAL DEVICE AND PLACEMENT IN THE MOUTH

After the setup was approved, the virtual malocclusion files and setup templates were exported from TMP to check the treatment plan once again (Fig. 15). Alternatively, they could be simply stored digitally in the patient’s medical record and transmitted to the office for further consultation “offline.”

The brackets and arcs of the lingual system were produced by a digital process and arrived at the orthodontist’s office in the form of a transparent, indirectly bonded splint. This splint was also manufactured by a digital process (Incognito Clear Precision Tray™) and was used for precise positioning of the attachments.

Figure 16 shows the splint bonded to the maxilla, placed on a model created by 3D impression using digitized data (the impression of the model is not indispensable; Fig. 16). The brackets are bonded with resin 3M ESPE RelyX Unicem 2 Automix™ and a self-adhesive cement (Fig. 17). In the same session, the vestibular device is placed on the mandible (Fig. 18, 19).
The arches had changed after 4 months and a transpalatal arch was placed in right unilateral expansion to correct arch asymmetries (Fig. 20).

An Angle’s class-II malocclusion appeared after leveling, and mandibular repositioning was needed to correct the initial deviation. At this stage, we placed occlusal wedges to facilitate articular orthopedic centering, after which we prescribed intermaxillary tractions for the patient (Fig. 21).
FINISHING AND ACCURACY FACILITATED BY DIGITAL SYSTEMS

When the multiattachment device was removed after 14 months of treatment (Figs. 22, 23), intraoral digital impressions were repeated over a few minutes with the patient seated in the chair.

These new impressions were also downloaded in STL format.

On the one hand, these models serve as a complement of the clinical photographs, allowing the verification of the new positions of the middle incisors, jaw asymmetries, etc. (Fig. 24). On the other hand, these virtual models can be used to analyze the results obtained in comparison to the previously downloaded models at the end of treatment.

These models were thus superimposed with those of the malocclusion, the setup, and the results, which is impossible to accomplish with physical models.

This superimposition facilitates a precise and reliable comparison by superimposing on the medial palatal
structures that were recorded during the intraoral digital impressions.

The visualization of the different possibilities of superimposing the digital models of the initial malocclusion, prediction by setup, and treatment results can all be analyzed in 3D (Figs. 25, 26).

These superimpositions show that the asymmetries have been removed as foreseen by the treatment plan developed on the basis of the setup models.

The frontal control radiograph confirmed the correction of the asymmetry (Fig. 27).
In addition, clinical observations of the joints showed that the pains and dyskinesia of the TMJ had disappeared. After this treatment period of 14 months with a fixed device, these final digital devices was used as a basis for planning the finishing steps with removable aligners and retainers.

A finishing setup (Fig. 28) was then developed, and physical models were edited with a 3D printer at the orthodontists’ office. These printed models were
Figure 30
Finishing aligners in the mouth.

Figure 31
Extraoral photo of the smile with aligners placed.
then used to produce aligners by thermofoming (Fig. 29). These splints made it possible to perfect the multiband orthodontic treatment (Figs. 30, 31).

CONCLUSION

As shown in this presentation, intraoral digital impressions are able to not only replace PVS in the treatment procedures but also assist orthodontists to improve the diagnosis and treatment as well as to better control the outcomes. The digital data produced by 3D intraoral scanning can be used and compared for better control over the movements of the teeth. Consequently, this allows us to develop a more precise understanding of orthodontic processes.

Conflict of interest: The author declares that they do not have any conflict of interest.