Computer-controlled implantology: Digital workflow facilitates resource-optimised treatment

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The success of dental implant reconstruction depends upon decisions made throughout the treatment process. The patient’s initial situation regarding the remaining structures, integrity of bone and soft tissue. The time required for various treatment alternatives must be carefully weighed, time is a resource crucial to the comfort and well-being of the patient and an important cost factor for the whole implant team.

Advancements in computer-based technology, including 3D imaging and advanced software applications, have made it possible to streamline and optimise the implant treatment workflow in ways that previously were unimaginable. The following comprehensive case illustrates the results that can be achieved when adopting a completely digital approach to treatment planning, implant placement and immediate seating of an aesthetic full maxillary restoration. This approach combines processes that until now have been independent, enabling successful low-pain (mixibility) delivery of an exceptional result.

Case presentation

A 65-year-old male patient presented with advanced periodontal disease. All his remaining maxillary teeth were loose (Figs. 1–5). The patient explained that he wanted a quick solution, with the caveat that he did not wish to be toothless at any time or to leave the practice with an obvious temporary restoration.

A CBCT scan was obtained, along with a precise impression and bite registration. No major treatment was planned for the mandible. Owing to the fact that all the maxillary teeth required extraction, a treatment plan incorporating immediate seating of a full arch restoration was developed, for which the patient presented with advanced periodontal disease. All his remaining maxillary teeth were loose (Figs. 1–5). The patient explained that he wanted a quick solution, with the caveat that he did not wish to be toothless at any time or to leave the practice with an obvious temporary restoration.

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satisfied with the virtual plan for the implants, the software was directed to fabricate the simulated bone-supported surgical guide (Fig. 27). The data was then sent via the Internet for stereolithographic (rapid-prototyping) fabrication of the resin surgical guide (Fig. 30). The implant-specific SIMPLANT SAFE surgical guide incorporated drilling sleeves to match the manufacturer’s drilling sequence (Fig. 30). In addition, a 3D printed model of the situation after implant placement was fabricated for use as a control model during manufacture of the temporary restoration. This optional step provided additional confidence in the accuracy of the temporary restoration. However, it is possible to make a temporary restoration using digital data exclusively (Figs. 33–36).

Fabrication of the temporary restoration

The digital workflow as described helps to facilitate the fabrication of a temporary restoration that must fit immediately and accurately after implant placement, as readjustment during the operation can be quite difficult, if not impossible. In order to provide a measure of safety, two temporary restorations...
were fabricated for this particular procedure. The first was produced digitally. The implant planning data was exported as STL files from the SIMPLANT software and imported into the CAD software (exocad DentalCAD, Figs. 33–36). The restoration was then designed in exocad DentalCAD based upon the location of each implant and abutment, and the diagnostic wax-up.

Once the design process had been completed, the CAM process was completed on a CNC milling machine, which milled the restoration from a solid block of PMMA (Figs. 37 & 39). As with most milled restorations, the restoration was not entirely finished when removed from the milling machine but required only a few additional manual steps for completion (Fig. 40). The holes intended to receive the abutments cylinders were designed for cement space of approximately 1 mm to ensure a passive fit. The screw channels were all opened occlusially (Fig. 39). Enamel and transparent composite material were applied to the milled teeth to add a hint of mamelons, enhancing the aesthetic appearance (Fig. 41). The second temporary restoration was fabricated by hand in the laboratory utilising the 3-D printed model and was based on a metal substructure (Fig. 42). Each restoration was designed to be worn by the patient throughout the anticipated three to six months of osseointegration. When both restorations were compared, they were the same size, but the handmade restoration appeared to be distinctly stronger (Fig. 43). When it was placed on the 3-D model, the aesthetic appearance was also satisfactory.

The surgical procedure
Surgery was carried out under general anaesthesia in the Princess Grace Hospital Centre in Monaco. The teeth were extracted and the extraction sockets were meticulously cleaned (Figs. 46 & 47). A gingival flap was reflected sufficiently to allow for the bone-supported surgical guide to be positioned on the alveolar ridge (Fig. 48). It fitted perfectly. The surgeon then followed the implant specific drilling protocol to prepare osteotomies for the eight implants (ANKYLOS C/L, DENTSPLY Implants; Fig. 49). The implants were placed alternately with the specially designed carriers that allowed for placement through the guide. The implants were strategically positioned and secured to prevent the guide from tipping and then blocking the implants with the positioning aid (Figs. 50 & 51). Once the surgical guide had been removed, Balance Base Abutments (ANKYLOS, DENTSPLY Implants) were connected (Figs. 52 & 53).

The surgeons judged that the two terminal implants could not sustain immediate loading, as the bone in those areas was too soft (Fig. 54). Bone graft material (Bio-Oss, Geistlich) was placed into the remaining sockets. A cover screw was placed and the areas were sutured so that the gingiva adapted well to the temporary restoration (Fig. 55).

The application of computer technology and advanced 3-D imaging in implant dentistry using multiple interactive software applications makes it possible to create advanced designs that are multifaceted, simultaneous, and precise, enabling true resource optimisation. In the clinical case, the design and production of a complex treatment plan were carried out using a state-of-the-art digital workflow. The data export procedure allowed for simulation of optimal abutment positioning. The CBCT image data was used to position the implants accurately within the desired envelope of the diagnostic wax-up, allowing for the restorative data to be exported for CAD and fabrication of the temporary restoration before the treatment on the patient had even begun. The analogue or manual working steps in the laboratory were replaced by the digital workflow as made possible through advanced computer-aided processes.

Resulting optimisation using digital workflow has great advantages for both patients and dental implant treatment teams. When it is possible to deliver an immediate-load restoration supported by sufficient dental implants, our patients can continue their lives with less psychological burden, and implant teams benefit from predictable operating procedures and efficiency. The craftsmanship of a competent dental technical specialist and the skill of a good dental surgeon when combined with 3-D preoperative planning can reduce operator and patient stress to a minimum, reduce patient morbidity and reduce surgical time, even when the operation must be relatively invasive, as represented by the clinical case illustrated. **AD**