Original Contributions

Case Report

The prototype concept in a full digital implant workflow

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ABSTRACT

Background. The aim of this case report is to describe the innovative concept of a prototype use in a digital implant workflow. A prototype is required for simultaneous evaluation of the accuracy of a dental impression and esthetic and functional parameters before final framework realization.

Case Description. Three digital impressions were obtained to create a master file, which contained information on the 3-dimensional (3D) position of the implant, the gingival architecture, and the esthetic and functional features of the provisional restoration. A stereolithographic master model (SMM) featuring implant analogs was 3D printed. Two prototypes were realized with the use of 2 different modalities. The first resin prototype (A), which lacked implant connections, was produced with the use of a certified digital workflow process. The titanium connections were luted onto the SMM. The second resin prototype (B), considered experimental, was a single piece with milled implant connections. Both prototypes were tested in the patient by means of visual inspection, finger pressure testing, screw resistance testing, and periapical radiography. In the case of accurate fit of prototype A or B on the SMM and misfit in the patient, the impression should be invalidated. For prototype B, in the case of proper fit in the patient and misfit on the SMM (because of the occurrence of an error during 3D printing, incorrect analog position, or both), the impression should be validated, but the model should be adapted.

Conclusions and Practical Implications. The use of a prototype allows the clinician to simultaneously test implant position and esthetic and functional parameters. However, a single-structure prototype could be preferable for the identification of impression inaccuracy.

Key Words. Dental implants; computer-aided design and computer-aided manufacturing; restorative dentistry; fixed prosthetics.

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Full-arch fixed implant restoration remains a major challenge in implant dentistry, but it is valuable, because it enables avoidance of complete denture rehabilitation.[1] When such restoration is required, computer-assisted surgical planning and a digital workflow can simplify the clinical and laboratory procedures.[2,3] Several steps are required to collect data on implant position and esthetic and occlusal relationships before proceeding to definitive restoration.[4] In the traditional workflow, a try-in structure made of titanium abutments linked by means of metal and resin is often used to verify the accuracy of the impression and the corresponding gypsum master model.[5] In the case of misfit, the resin structure can be cut and fixed with new resin when secured directly onto the implants; then, the passive-fitting resin structure is used to reposition the implant analogs in the appropriate position on the model. During the second appointment, the clinician intraorally evaluates the accuracy of the definitive framework (made of titanium or cobalt-chromium alloy).[6] A third appointment is necessary to check occlusal and esthetic aspects with the use of a definitive framework covered with resin molded from the wax-up.[7] Only after such verification procedures are complete can the dental technician finalize the definitive restoration with the use of a resin or ceramic-layering material. The application of a fully digital workflow can eliminate the need for some of these stages.[8] A prototype that emulates the anatomic shape of the provisional restoration and accurate implant positioning is a useful tool for evaluating all parameters

Figure 1. Initial clinical case.

mentioned above during a single appointment. The dental literature contains no description of the use of a 3-dimensional (3D) printed prototype to check implant position and esthetic and occlusal parameters. The aim of this case report is to describe the use of computer-aided design and computer-aided manufacturing prototypes to check all prosthetic and functional parameters simultaneously.

CASE REPORT

A clinical case that required a full-arch implant restoration was selected to illustrate the applications and limits of different prototypes (Figure 1). After creating a wax-up denture to feature the correct occlusal and esthetic parameters, a resin radiographic template suitable for cone-beam computed tomography was produced. Computer-assisted implant planning was performed, and 6 implants (4.1 RN, Straumann) were inserted in the maxilla with the use of a 3D printed surgical template. A provisional metal-resin restoration that incorporated the esthetic and functional parameters copied from the wax-up was placed during the healing period. Six months later, an intraoral digital scanner (True Definition Scanner, 3M ESPE) was used to obtain 3 different sets of digital impressions, in line with the principles of a fully digital technique.[9] The first set (STL1) consisted of intraoral digital impressions of the maxillary and mandibular arches, the lateral bites of the provisional restoration, and the surrounding gingival tissue. Thus, STL1 contained information on the occlusal vertical dimensions, maximal intercuspations, anterior and lateral guidance, and the relationship between the provisional restoration and the vestibular/buccal portions of the gingival tissue. The provisional restoration was then removed and 6 standardized scan bodies (Scanbody with RN Platform, Straumann) were secured to the implants (Figure 2A). The second set of digital impressions of the scan bodies were obtained, yielding their 3D spatial positions (STL2). Out-of-mouth scanning of the provisional restoration that captured the peri-implant soft tissue of the provisional restoration, and the pontic elements, constituted the third set of digital impressions (STL3). STLs 1 through 3 were superimposed with the use of dental software (DWOS, Dental Wings) to obtain a single file, termed the digital master model, which contained the 3D implant positions, the esthetic and occlusal parameters, information on the peri-implant soft tissue, and the shapes of the pontic elements (Figure 2B). A stereolithographic master model (SMM) with inserted implant analogs was then 3D printed (Dreve, Dreve Dentamid) based on the digital master model (Figure 2C). As in the traditional workflow, after creating the digital impression but before realization of the metal framework, it was essential to use a prototype to check 4 key elements (the implant 3D position, the esthetic and occlusal parameters, and the gingival profile) to avoid framework inaccuracies, optimize esthetic and functional factors, and reduce treatment time. Two different digital workflows can be used to realize an esthetic and functional prototype.

Certified workflow: prototype A

A milled resin prototype (prototype A) was created starting from the full-arch implant digital impression (Straumann CARES, Straumann). This prototype was produced without implant connections and was finalized by means of luting standard metal connections (Variobase,

ABBREVIATION KEY

DMM: Digital master model.
SMM: Stereolithographic master model.
STL: Set of digital impressions.
3D: Three-dimensional.