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Digital workflow for full-arch immediate loading: Dynamic navigation and 3D printing fixed dental prostheses

KEYWORDS
All-on-X;
FastMap;
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In patients with complete edentulism, multiple missing teeth, or advanced periodontal disease, occlusal reconstruction was typically required to reestablish proper oral function.[1] Traditional full-mouth reconstruction typically involved several appointments for surgical assessment, impression procedures, surgical and the fabrication of fixed dental prostheses (FDPs). Advancements in digital dentistry had partially replaced traditional procedures, leading to shorter treatment durations and enhanced surgical precision.[2] Therefore, many dental implant surgeries allowed for the immediate placement of fixed dental prostheses on the day of implant placement, completing the treatment in a single visit. As dental surgical equipment and techniques improved, clinical practice gradually shifted from restoring individual teeth to performing full-arch rehabilitations.[3] Through updates in software, equipment, and artificial intelligence, dental technicians introduced innovative applications that effectively shortened the production time of FDPs.[4,5] Accordingly, this study aimed to introduce a clinical approach that utilized dynamic navigation and 3D printing technologies to fabricate full-arch immediate loading fixed dental prostheses.

Full-arch reconstruction was required in this study due to extensive bone loss exceeding 70 % in most teeth, accompanied by esthetic compromise. The complete treatment process is illustrated in Fig. 1. Computed tomography (Rayscan S-SC, Ray, Seoul, South Korea) was used to evaluate the condition of the teeth as well as the surrounding soft and hard oral tissues (Fig. 1A). Digital models of the maxilla (Fig. 1B) and mandible (Fig. 1C) were obtained using an intraoral scanner (TRIOS 3, 3Shape, Copenhagen, Denmark). Surgical planning for implant placement in the maxilla (Fig. 1D) and mandible (Fig. 1E) was performed using DTX Studio Implant software (Version 3.6.9.3, Nobel Biocare, Zurich, Switzerland). Implant placement was guided using the X-Guide system (X-Nav Technologies, LLC, Lansdale, PA, USA), followed by the installation of scan bodies. A FastMap method, similar to photogrammetry, was used by the dentist to scan the scan bodies and accurately determine the implant positions (Fig. 1F). Prosthetic design was performed by the dental technician using dental design software (exocad, Darmstadt, Germany) (Fig. 1G), followed by the fabrication of resin fixed dental prostheses through 3D printing. The FDPs were delivered intraorally to verify their morphology and occlusion (Fig. 1H). Finally, computed tomography was performed again to assess the fit of the FDPs, completing the treatment process (Fig. 1I). According to the case described in this study, a total of 2–4 weeks was required for preoperative planning and interdisciplinary discussion. On the day of surgery, the procedures for the maxilla and mandible required approximately 2.5 h and 2.0 h, respectively. The total duration from the initiation of surgery to the acquisition of the final computed tomography images was approximately 8.0 h. This treatment protocol enabled same-day surgical completion and allowed the patient to regain masticatory function and oral rehabilitation immediately.

Although the fabrication of immediately loaded FDPs required close collaboration between experienced dentists and dental technicians, the digital workflow still helped streamline the process. However, as digital dental

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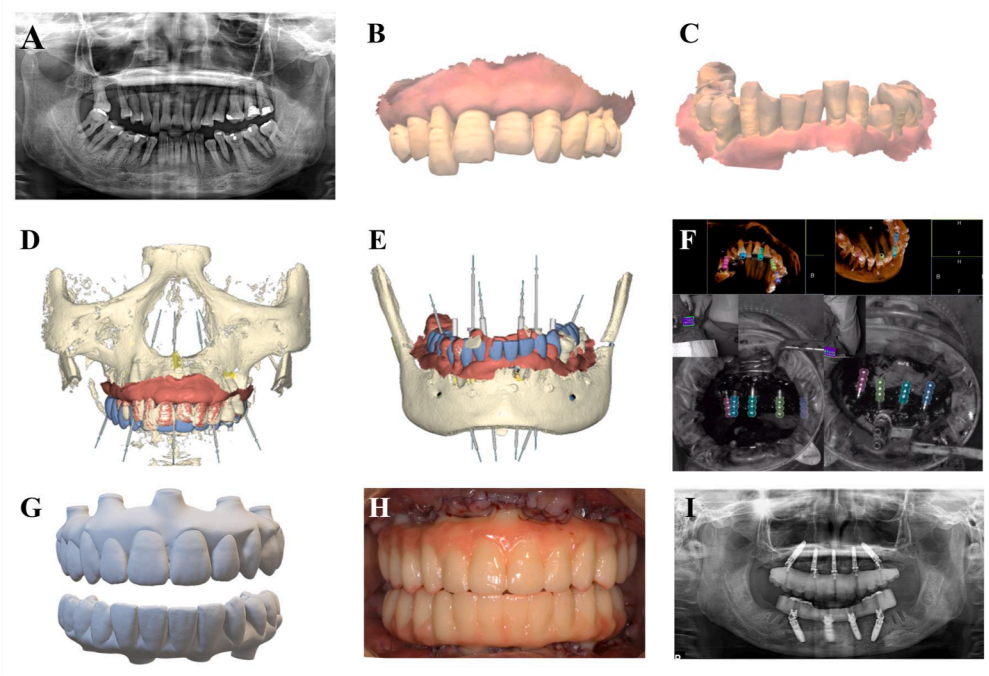

Figure 1 Dynamic navigation was utilized to complete the immediate loading full-arch fixed dental prostheses workflow. (A) X-ray images were taken before surgery. (B) A digital model of the maxilla was created. (C) A digital model of the mandible was created. (D) A 3D model of the maxilla was generated for surgical planning. (E) A 3D model of the mandible was generated for surgical planning. (F) The scan body was positioned in the X-Guide system. (G) Digital design of fixed dental prostheses. (H) Intraoral photograph of fixed dental prostheses after installation. (I) X-ray images were taken after surgery.

technologies continued to advance and become more widely adopted, further improvements were expected. Future dental treatments are expected to continue advancing toward greater accuracy, speed, and safety, ultimately enhancing the quality of patient care.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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