A Digital Workflow for Implant Treatment and Occlusal Reconstruction in a Patient with an Edentulous Mandible: A Case History Report

Chao Liang, MDS
Xiao Lin, PhD
Department of Dental Implant Center, Beijing Stomatological Hospital, School of Stomatology, Capital Medical University, Beijing, China.

Jun Li, PhD
Department of Dental Implant Center, Beijing Key Laboratory of Tooth Regeneration and Function Reconstruction, Beijing Stomatological Hospital, School of Stomatology, Capital Medical University, Beijing, China.

Wei Geng, PhD
Department of Dental Implant Center, Beijing Stomatological Hospital, School of Stomatology, Capital Medical University, Beijing, China.

This case history report describes a comprehensive digital workflow for implant treatment and occlusal reconstruction to provide a systematic protocol for implant-supported restorations in edentulous patients. In this case, a restoration-oriented surgical protocol was created using an oral implant planning and design software. The implant surgery was completed under the guidance of a fully guided surgical template. This is the first report of the combined application of computer-aided diagnosis axiograph and neuromuscular evaluation systems in implant-supported occlusal reconstruction. Digital technologies can increase the accuracy, efficiency, and comfort of implant treatment and achieve satisfactory occlusal reconstruction outcomes in edentulous patients. Int J Prosthodont 2020;33:565–571. doi: 10.11607/ijp.6614

Digital technologies can overcome the artificial errors of traditional implant restoration methods for edentulous patients, bringing implant surgery and occlusal reconstruction in line with the concepts of precision medicine and personalized medicine.1 Throughout the entire course of implant restoration, occlusal reconstruction is the most complex part for edentulous patients. Determining how to accurately reconstruct the occlusal plane in coordination with the ideal state of both the masticatory neuromuscular and temporomandibular joint (TMJ) systems is currently the most significant challenge.2,3 The combined application of neuromuscular evaluation and computer-aided diagnosis axiograph (CADIAX) systems for visualizing and evaluating the conditions of the nerves, muscles, and joints during therapy is a good way to address this problem.

This study summarizes a new comprehensive digital workflow for implant treatment and occlusal reconstruction in a patient with an edentulous mandible.

CASE HISTORY

A 43-year-old female patient had worn a conventional mandibular complete denture for 7 years and requested implant-supported fixed restoration treatment. Oral examination confirmed the missing teeth (38–48, 26 [FDI]) and a narrow alveolar
ridge due to bone resorption. The treatment plan was a digitally assisted implant-supported fixed restoration.

The software coDiagnostiX 9 (Dental Wings) was used to develop an implant surgical plan (Fig 1a). Six implants (SLActive Bone Level Guided, Straumann) were inserted at tooth sites 32, 34, 36, 42, 44, and 46 under the guidance of a fully guided surgical template (Figs 1b to 1d), and the accuracy of the surgery was confirmed by coDiagnostiX 9 software according to CBCT (Figs 1e and 1f). Immediate restoration was performed using the intraoral pick-up technique after surgery (Figs 1g to 1i).

The K7 Evaluation System (Myotronics) was applied to evaluate nerve and masticatory muscle function and mandibular movement while the first interim restoration was in use (Fig 2). Based on the K7 data, clinical fine occlusal adjustment was performed to optimize the free-way space and lateral movement.

After 3 months, the CADIAX system (GAMMA) was used to record the real-time motion trajectory of the patient’s bilateral condyles (Figs 3a to 3e), and the maxillomandibular relationships were transferred to the fully adjustable articulator according to the condyle data (Fig 3f). Meanwhile, CBCT revealed that the condylar morphology and joint space were largely normal (Fig 3g). An esthetic wax-up was finely adjusted on the articulator and tested intraorally (Fig 3h), and CAD/CAM technology was used to complete the second resin interim restoration (Figs 3i to 3j). Three months later, K7 analyses were repeated to confirm the effect of occlusal reconstruction (Fig 2).

Finally, the titanium framework and zirconia crowns of the permanent restoration were designed using exocad software (Figs 4a to 4f). Intraoral pictures and CBCT scans were taken to record the conditions of the permanent restoration and implants (Figs 4g to 4h). T-Scan III (Tekscan) was used to detect dynamic occlusion and to guide occlusal adjustment (Fig 4i).

The patient was examined after 3 months, 6 months, 1 year, and 2 years of follow-up, and no surgical or prosthodontic complications were reported. The mandibular movement was coordinated with the nerves, muscles, and joints, and the patient was satisfied with the denture.

**DISCUSSION**

The neuromuscular system, the TMJs, and the dental restoration are the three necessary elements of occlusal reconstruction, and the coordination of these three elements is the basis for a long-term stable occlusal relationship.

The classic theory proposed by Dawson suggests that the basic goal of occlusal reconstruction therapy is to establish a “coordinated and stable neuromuscular system” thus, it is worthwhile to use a neuromuscular evaluation system to test myoelectricity and mandibular movement range to verify whether the relationship between the masticatory muscles and the occlusion is coordinated when the implant-supported denture is in use. Furthermore, Slavicek believed that accurate recording of the maxillomandibular relationship in reference to condylar movement is key to obtaining good results for implant-supported complete denture restoration, and the CADIAX system plays an important role in this process. Only if the three elements of occlusal reconstruction are balanced can the normal physiologic function of the oral and maxillofacial system be adequately restored.

Digital techniques enable dentists to achieve predictable and reproducible therapeutic effects in a clear manner. With the development of digital technology, implant restoration treatment is bound to continue advancing toward the goal of achieving precision and personalized medicine in both the present and the near future.

**ACKNOWLEDGMENTS**

This study was supported by the High Level Health Technical Personnel in Beijing Preferred Foundation (2015-3-091). The authors report no conflicts of interest.

**REFERENCES**

Fig 1  (a) Designs of implant insertion sites. (b) Digital surgical template. (c) Template fabricated using additive manufacturing technology. (d) Six implants were inserted under template guidance. (e) CBCT radiograph following surgery. (f) Superimposed CBCT scans showing the accuracy of implant insertion. (g–i) Immediate restoration placed using the pick-up technique.
Fig 2  Neuromuscular evaluations of the first (left) and second (right) interim restorations with the K7 system.
Fig 2 (cont’d) Neuromuscular evaluations of the first (left) and second (right) interim restorations with the K7 system.

Figs 3a to 3d Real-time motion trajectories of bilateral condyles recorded by the CADIAX system.
Figs 3e to 3j  (e) Recording with CADAX system. (f) Fully adjustable articulator. (g) CBCT examination of the TMJs. (h) Wax try-in of the second interim restoration. (i) Screw-channel design by exocad. (j) Second interim restoration in situ.
Fig 4 (a) Titanium framework design. (b and c) Framework try-in. (d and e) Zirconia crowns made using the CAD/CAM process. (f, g) Permanent restoration in situ. (h) CBCT radiograph of implants and restoration. (i) Occlusal examination with the T-Scan III system.