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DENTAL TECHNIQUE

The creation of a virtual dental patient with dynamic occlusion and its application in esthetic dentistry

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ABSTRACT

The application of a virtual dental patient with dynamic occlusion during esthetic restoration in a digital workflow is described. An intraoral scanner, a facial scanner, a jaw motion analyzer, and cone beam computed tomography were used to transfer patient data and construct the virtual dental patient. With the aid of the virtual dental patient, predictability and accuracy can increase throughout treatment, simplifying the clinical evaluation and prosthesis adjustment with improved esthetic outcomes. (J Prosthet Dent 2020;■:■-■)

Digital technology has resulted in great advances in contemporary dentistry, and computer-aided design and computer-aided manufacturing (CAD-CAM) has been applied widely. However, many dental laboratory technicians still work with mechanical devices such as mechanical articulators.[1,2] Currently, CAD-CAM procedures generally consider only static occlusion instead of dynamic occlusion, which is hard to reproduce.[3] The restoration's occlusal anatomy, position, and height are essential for both esthetics and function,[4,5] and errors may contribute to interceptive and deflective tooth contacts.[6]

Intraoral scanners are gradually replacing traditional impression-making techniques,[7] and a jaw motion analyzer can record the exact movements of the mandible and then move digitized dental arches along those paths in the computer. Therefore, static and kinematic occlusal collisions can be visualized with these tools.[8]

Data from an intraoral scanner, a facial scanner, a jaw motion analyzer, and cone beam computed tomography (CBCT) can construct a virtual dental patient model with dynamic occlusion. The virtual dental patient integrates digital 3D diagnostic data, such as extraoral soft tissue, craniofacial hard tissue, remaining dentition (including intraoral soft tissue), and dynamic occlusion.[9] With this virtual patient, crowns are made to restore the maxillary incisors, and a 3D surgical template is printed to guide crown-lengthening surgery.

TECHNIQUE

The technique is described on a 25-year-old man who attended the Digital Stomatology Center of Tongji University seeking an esthetic restoration of a fractured maxillary incisor. The patient had an increased vertical overlap subsequent to abnormal passive teeth eruption (Fig. 1) and defective endodontic treatment in the 3 of the maxillary incisors. The maxillary left lateral incisor had a large discolored composite resin restoration. The patient declined orthodontic treatment and accepted crown-lengthening surgery and complete crown restorations. After endodontic treatment, the treatment included the

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Figure 1. Initial condition. A, Full-face view. B, Smile view. C, Intraoral view.

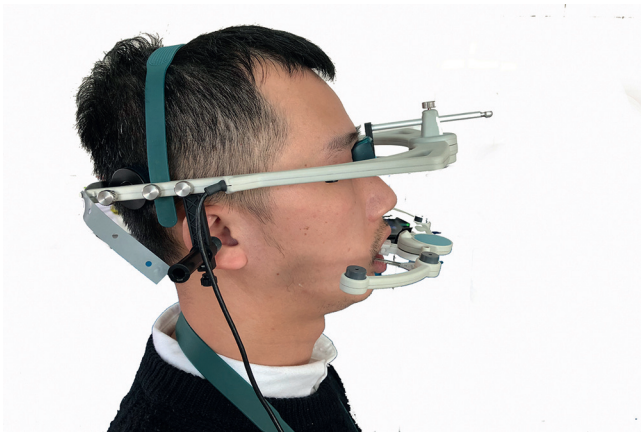

Figure 2. Mandibular movement trajectories including lateral movement, protrusive movement, opening movement, and mastication recorded by using jaw motion analyzer.

creation of a virtual dental patient with the following procedures.

1. Scan the maxillary and mandibular arches and the intercuspal position by using an intraoral scanner (CEREC AC; Dentsply Sirona) and export the data as standard tessellation language (STL) format files.
2. Capture the facial soft tissue contours at the patient's exaggerated smile and intercuspal position by using a facial scanner (Bellus3D Dental Pro; Bellus3D GmbH) and export the data as object (OBJ) format files.
3. Make a CBCT scan of the maxilla and mandible in the intercuspal position and export the data as digital imaging and communications in medicine (DICOM) format files.
4. Record the patient's jaw movement trajectories by using the jaw motion analyzer (JMAnalyser+; zebris Medical GmbH) (Fig. 2) and export the data as extensible markup language (XML) format files.
5. Import the data of the intraoral scanner, facial scanner, CBCT scan, and jaw motion analyzer into a digital dental software program (exocad dental CAD; exocad GmbH). Based on teeth, fixed points on the forehead, and other tissue markers matched by the facebow fork, merge all these data to create a virtual dental patient (Fig. 3).
6. Determine the position and shape of the gingival margin and the definitive restorations in the digital dental software program based on the virtual dental patient. From this, design the surgical template and the 3D esthetic analysis cast and print them (Fig. 4A, 4B). Perform the crown-lengthening surgery guided by the surgical template (Fig. 4C). Fabricate and seat the interim restorations.
7. After 6 months, when the gingival contours have stabilized, remove the interim restorations, and prepare the teeth. Rescan both dental arches by using the intraoral scanner and import the data into the digital dental software program.
8. Make ceramic crowns (Lava Plus High Translucency Zirconia; 3M ESPE) according to the design of the digital dental software program (Fig. 5). Apply and sinter veneering porcelain and glaze the labial surfaces of the crowns.
9. Clinically evaluate and cement the definitive restorations (Fig. 6A). Instruct the patient to perform jaw movements and use articulating paper to evaluate the restorations. The maxillary and mandibular anterior teeth should be in light contact in centric occlusion. The protrusive movement should be smooth, leaving a continuous linear imprint (Fig. 6B). Occlusal interferences should be absent, and adjustment should not be required.

The completed restorations are seen in Figure 7.

DISCUSSION

This article describes how to create a virtual dental patient and apply the process to esthetic dentistry in a digital workflow. The virtual dental patient compensates for the lack of dynamic occlusal relationships in the current CAD-CAM systems.

An advantage of the described technique is the increased predictability from virtual design to actual outcomes. Preoperative simulations generated by CAD-CAM allow dentists to design restorations for

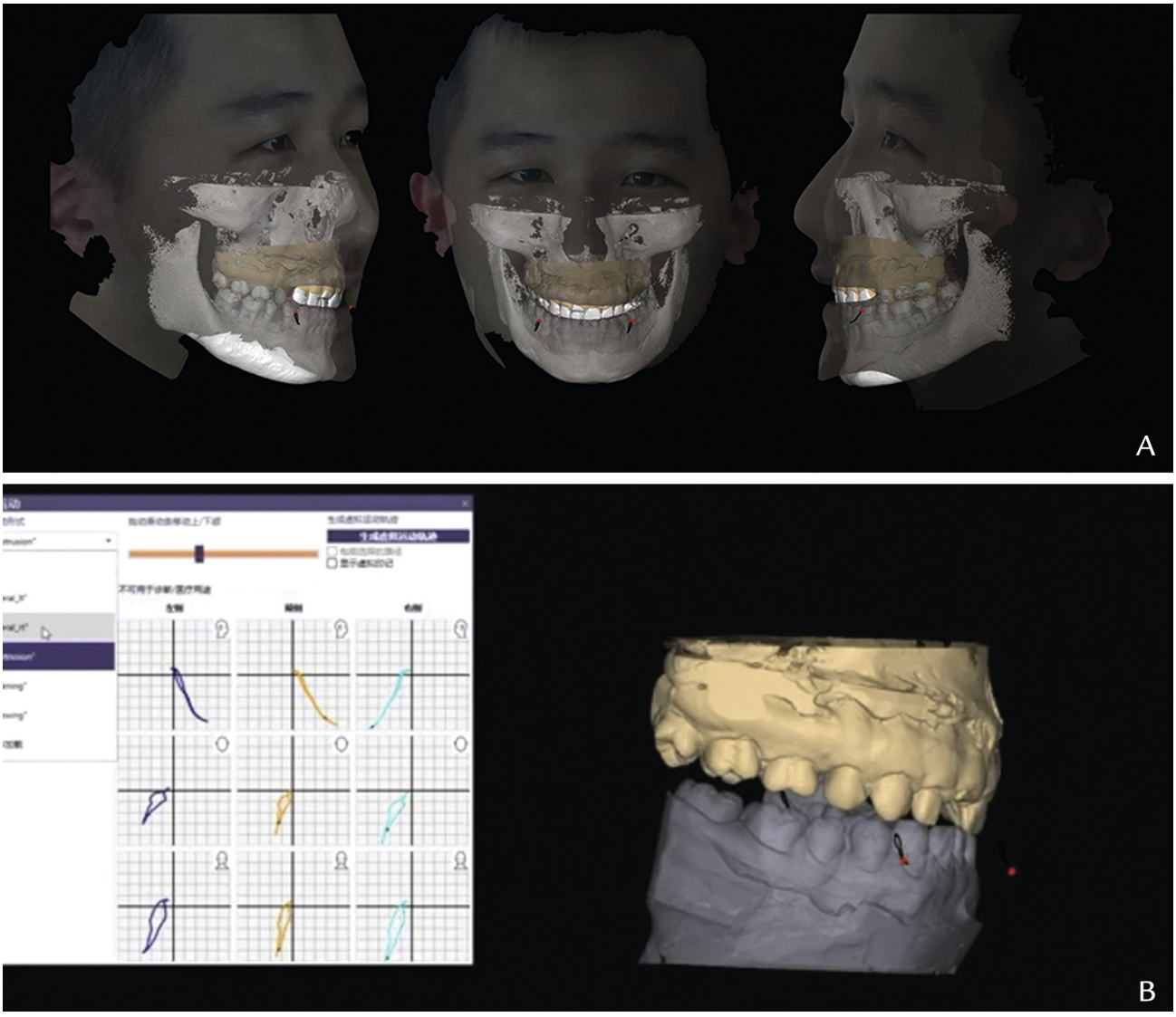

Figure 3. A, Virtual patient with dynamic occlusion. B, Video still.

Figure 4. A, Design of tooth shape, gingival margin, and surgical template. B, Three-dimesionally printed esthetic analysis cast and surgical template. C, Gingival margin contoured as indicated by surgical template.

patients to evaluate and accept before irreversible procedures, which facilitates patient communication.[10] Furthermore, when performing the crown-lengthening surgery, the 3D-printed surgical template that had been digitally designed according to the virtual dental patient should minimize surgical errors and improve predictability in obtaining an ideal gingival and alveolar contour.[11]

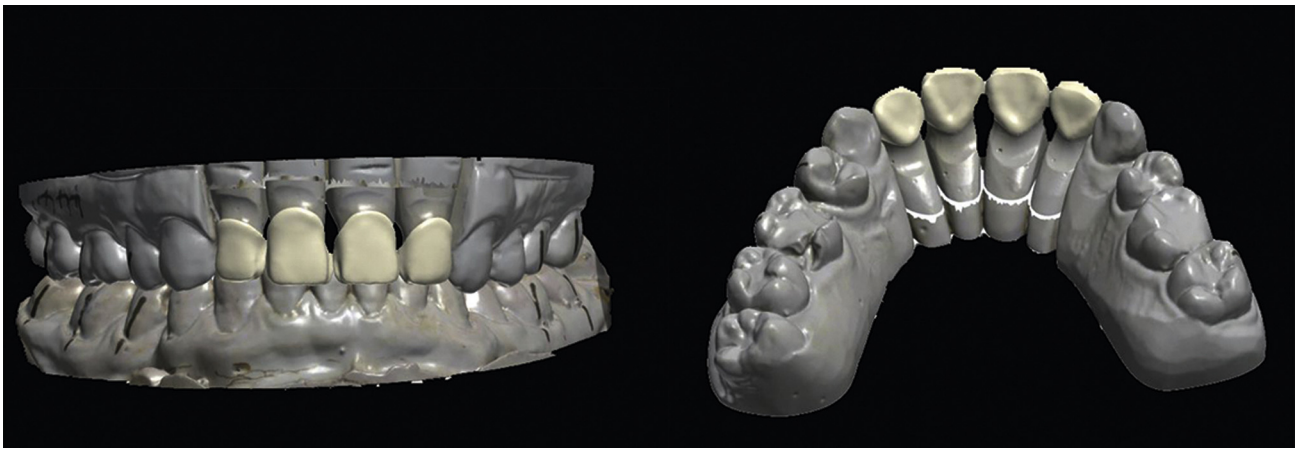

Figure 5. Design of lingual shape of crowns.

Figure 6. A, Definitive restorations. B, Blue marks indicate centric occlusion; red marks indicate protrusive movement.

Figure 7. Appearance after 6 months. A, Intraoral view. B, Full-face view.

An accurate occlusal relationship is essential for a successful restoration. Restorations made on mechanical articulators can be affected by errors resulting from their complexity, which may lead to an inaccurate occlusion. In addition, they are difficult to incorporate into a digital process.[12] Therefore, the jaw motion analyzer appears to be more suitable, allowing CAD-CAM to generate an appropriately shaped restoration, especially the lingual surfaces, leading to reduced processing time and less possibility of occlusal interferences or occlusal adjustments of the definitive restoration.

SUMMARY

This article describes the development and application of the virtual dental patient with dynamic occlusion applied for crown-lengthening surgery and esthetic restoration, resulting in a predictable and satisfactory outcome.

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