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Dynamic navigation method for rapid confirmation of multi-unit abutment position and angulation

KEYWORDS
Dynamic navigation;
Multi-unit abutment;
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With advances in modern dental clinical technology, the superimposition of digital files enables precise prediction of the positions of dental implants, abutments, and prostheses for preoperative simulation and planning.[1,2] With the maturation of dynamic navigation technology, the treatment of complete-arch immediate loading prostheses has been significantly enhanced.[3] It significantly reduces treatment time and enhances accuracy.

As part of the complete-arch prosthesis workflow, the connection between the dental implant and the prosthesis is established through a multi-unit abutment (MUA).[4,5] However, the accurate rotation and positioning of the MUA remain challenging, and any misplacement can cause discrepancies between its actual angulation and the predesigned screw accesses in the prefabricated prosthesis (Fig. 1A and B). Given that precise alignment of the MUA with the prosthetic screw accesses remained a major challenge in complete-arch implant treatment, this report presented a dynamic navigation-based method for rapid confirmation of MUA position and angulation.

The preoperative implant positions, screw accesses, and prosthesis design were planned using the implant planning software (DTX Studio Implant software, version 3.6.9.3; Nobel Biocare, Zurich, Switzerland) and exported as standard tessellation language (STL) files (Fig. 1C). These files were reoriented in the open-source computer-aided design (CAD) software (Meshmixer; Autodesk, San Rafael, CA, USA) and then imported into the dynamic navigation planning software (IconiX AI; X-Nav Technologies, LLC, Lansdale, PA, USA). Subsequently, the spatial relationships among the MUA, screw accesses, and prosthesis were visualized within the dynamic navigation planning software (Fig. 1D). During the surgery, a surgical handpiece was used intraorally to check the MUA position (Fig. 1E). Since slight deviations in implant placement (such as position, depth, or angulation) could occur, the dynamic navigation unit displayed both the actual MUA position and the original MUA design file in real time, allowing verification of the magnitude and direction of deviation (Fig. 1F). The metallic handles were attached to the MUAs, and with the assistance of dynamic navigation, the planned direction of screw access on the MUA was checked using the surgical handpiece and drill (Fig. 1G). Since the MUA screw access was oriented toward the buccal side, the implant or MUA needed to be rotated to shift the screw access orientation toward the lingual side (Fig. 1H). After adjusting the angulation intraorally, the MUA handle was reattached (Fig. 1I). Finally, the MUA screw access was re-evaluated in the software to confirm its position on the prosthesis. The results showed that the alignment of screw access on the prosthesis was consequently improved and coincided with the preoperative planning (Fig. 1J).

The primary purpose of this study was to prevent errors in the position and angulation of the prosthetic screw accesses. The unfavorable accesses to the prosthesis not only compromise esthetics but also reduce the structural integrity in thinner areas. The limitation of this report was that the implant placement position, angulation, and depth could not deviate excessively; otherwise, excessive adjustments to the implant and MUA could result in time-consuming and

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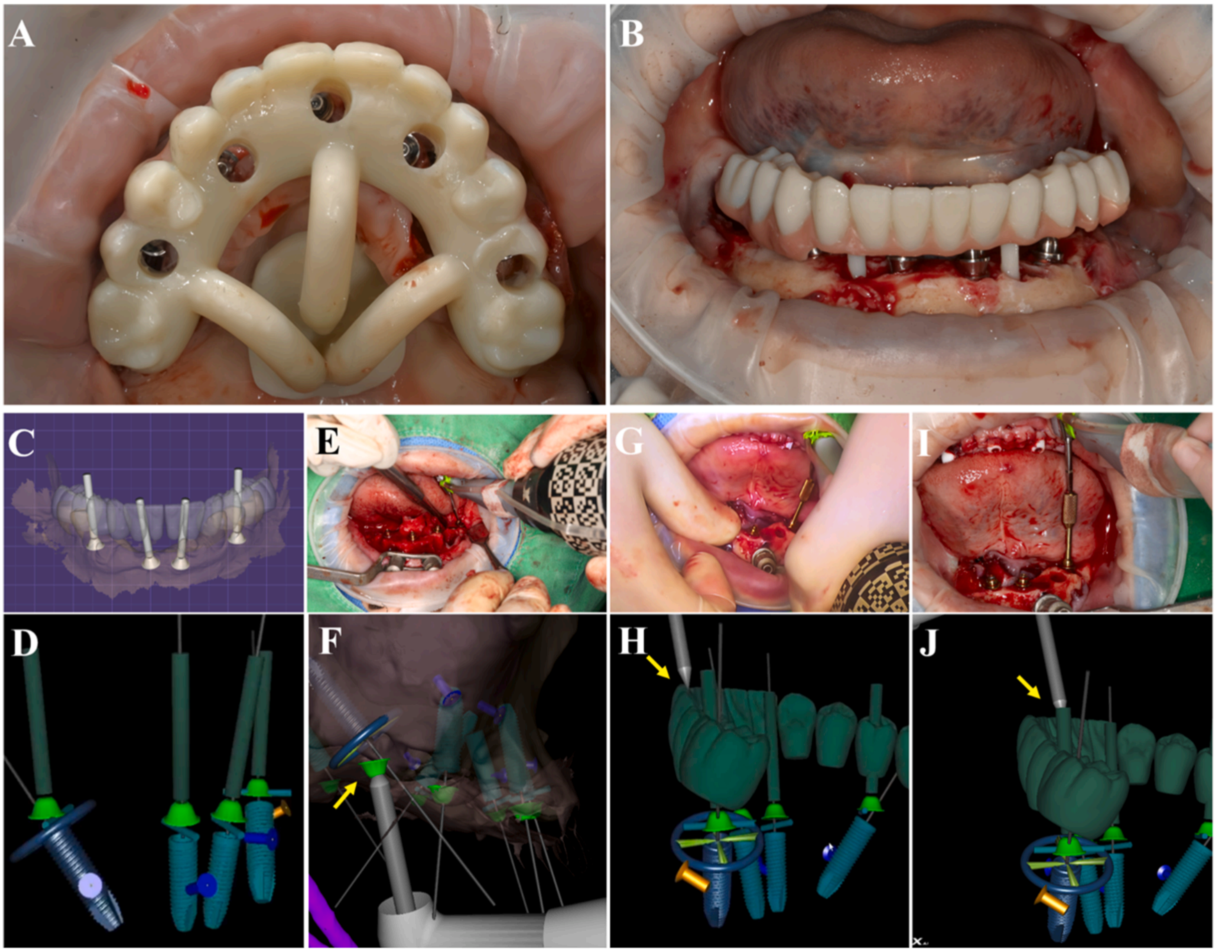

Figure 1 Using dynamic navigation to rapidly verify the position and angle of multi-unit abutment (MUA). (A) Using the analog method (screw access template) to verify the position of the MUAs in the maxilla. (B) Another analog method using a prefabricated interim prosthesis with guide pins to verify the position of the MUA in the mandible. (C) Digital files of the model, MUAs, and prosthesis. (D) Superimposition of all digital files in the dynamic navigation planning software. (E) Verification of intraoral MUA positions using the surgical handpiece with a bur after length registration of the bur. (F) Identifying MUA deviations in X-Guide Iconix. (G) Install the MUA handle and use the surgical handpiece and bur to verify the relationship between the screw channel and the denture under navigation assistance. (H) Reviewing the differences between the planned prosthetic screw access and the actual position in the software. (I) After repositioning the MUA, verify the correct screw access. (J) Assessing the final MUA position and angulation in dynamic navigation planning software.
*The yellow arrow indicates the contact point between the dental handpiece and the top of the MUA handle. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

reduced accuracy. In addition, if unfavorable bone conditions or intraoperative treatment-plan modifications occur, the chairside-conversion method using a complete denture or the fabrication of a new interim implant-supported prosthesis from the postoperative photogrammetry or intraoral scan is a more suitable alternative strategy. Therefore, this study is ideal for cases that follow the planned implant surgical protocol. With the assistance of digital files and dynamic navigation technology, the MUA and prosthesis were adjusted to their optimal planned positions, enhancing the overall treatment quality.

Declaration of competing interest

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

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