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Short Communication

Dynamic navigation-assisted implant placement for the jaw-in-a-day mandibular reconstruction

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Abstract *Background/purpose:* Jaw-in-a-Day (JIAD) integrates oncologic resection, fibula free-flap reconstruction, and immediate implant-supported prosthetic rehabilitation in a single operation. This study aimed to use the dynamic navigation-assisted implant placement for the JIAD mandibular reconstruction.
Materials and methods: We reported a JIAD case employing a hybrid workflow that combined conventional static guides with intraoperative dynamic navigation to enhance implant placement accuracy. Comprehensive computer-aided surgical simulation and virtual surgical planning were performed using Mimics and 3Shape software, followed by the navigation-assisted implant placement during fibula preparation.
Results: The postoperative course was uneventful, and the patient was discharged three weeks after surgery. The 2-month postoperative cone-beam computed tomography demonstrated that angular deviation, platform depth deviation, and apical depth deviation were all within reported ranges for dynamic navigation—guided implant placement.
Conclusion: Incorporation of dynamic navigation into the JIAD workflow provides intraoperative adaptability and improve implant accuracy and reconstructive reliability in a complex mandibular reconstruction.

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Introduction

Mandibular reconstruction following oncologic resection remains a major challenge for the oral and maxillofacial surgeons. The primary objectives include restoring facial form and function by reconstructing the skeletal buttresses and re-establishing both external and internal soft-tissue envelopes, thereby providing an appropriate foundation for functional dental rehabilitation.[1] Computer-aided surgical simulation (CASS) has revolutionized clinical precision medicine, particularly in virtual surgical planning (VSP) for the oral and maxillofacial surgeries. CASS stands out for its superior precision, improved reproducibility, reduced morbidity, and shorter operative times.[2]

The jaw-in-a-day (JIAD) procedure has emerged as a popular reconstructive strategy, combining the segmental mandibulectomy, immediate fibula flap reconstruction, and simultaneous implant placement with prosthetic connection in a single operation. The first JIAD case was performed in 2007 by a British surgical-prosthodontic team with only minimal digital assistance.[3] A fully digital workflow was later introduced by Levine et al., in 2013, highlighting multidisciplinary collaboration and a completely guided surgical pathway.[4] Despite these advancements, achieving optimal accuracy in implant positioning and bone reconstruction continues to pose challenges.

Guided implant surgery has demonstrated favorable prosthetic outcomes, high implant survival rates, and improved long-term peri-implant tissue stability. Dynamic navigation and static surgical guides are the two predominant approaches. Dynamic navigation offers intraoperative flexibility and real-time visualization.[5,6] Given the unpredictable thickness of the muscle cuff surrounding the harvested fibula flap, which may compromise the accuracy of guide seating. We hypothesized that incorporating dynamic navigation into the implant placement phase may enhance accuracy compared with a purely static guide protocol.

Materials and methods

A 58-year-old man was diagnosed with stage II (cT2N0M0) squamous cell carcinoma of the right mandibular gingiva (Fig. 1A). The patient expressed a strong interest in immediate dental rehabilitation. After thorough consultation, he elected to undergo wide excision of the tumor with segmental mandibulectomy and ipsilateral neck dissection, followed by immediate reconstruction using a free fibula flap with simultaneous implant placement and provisional prosthesis connection. A CASS-based workflow was initiated to support the planned JIAD procedure.

Preoperative evaluation included maxillofacial computed tomography (CT), CT angiography (CTA) of both lower extremities, and an intraoral scan. The CT slice thickness was set at 0.6 mm. All imaging data were imported into the planning software in digital imaging and communications in medicine (DICOM) format, and the intraoral scans were processed as stereolithography (STL) files. The virtual planning was performed using Materialise Mimics Core, Materialise 3-matic Medical, and Mimics Enlight CMF, while the implant planning was conducted using 3Shape Implant Studio.

The CASS planning followed a stepwise protocol. Segmentation included the skull, diseased mandible, left fibula, and left peroneal artery. Two virtual osteotomies with appropriate oncologic margins were created. Following the virtual resection, reconstruction was planned to use a single-segment fibula flap. The laterality and orientation of the flap were determined based on the diagnostic wax-up, desired mandibular contour, location of the defect, and anticipated recipient vessels (Fig. 1B and C).

The diseased mandible, osteotomies, reconstructed mandible, and fibula bone were exported for virtual implant placement and formation of the titanium reconstruction plate and surgical guides. A preformed titanium plate was bent, and screw-hole positions were transferred using a 3D scanner so that the predicted holes could be incorporated into the guide designs. Two genesis tapered implants (Keystone Dental Group, Irvine, CA, USA), 4.5 mm in diameter, were virtually positioned in implant studio and transferred into the mimics software environment using implant sleeves (Fig. 1C). A mandibular guide, fibula guide, mandibular defect model, and temporary floating prosthesis were fabricated for the fully guided JIAD workflow.

Utilizing the DICOM of lower extremity CT, STL files of the planned implant position and the fibula guide, the dynamic navigation was set up for the implant placement during the fibula part of the surgery using X-Guide system (X-Nav Technologies, Lansdale, PA, USA) (Fig. 1D).

The surgical procedure was performed as follows. After exposure to the mandible, the mandibular guide was secured and verified for accurate fit. All predictive drilling was performed prior to segmental osteotomy to maintain guide stability. Following fibula harvest, the fibula guide was fixed with monocortical screws, and predictive drilling was completed. The implant placement was then executed under the dynamic navigation (Fig. 1E). Subsequently, the fibula osteotomies were performed, and the fibula segment with implants was fixed onto the mandibular defect model using the prebent plate. Multi-unit abutments (MUAs) and temporary cylinders were connected, and the flap laterality was confirmed with the floating prosthesis. After relining the prosthesis, the pedicle was prepared, and the implant-fibula-plate complex was transferred to the defect. The reconstruction plate was secured to the native mandible using the bicortical screws placed into the predictive holes.

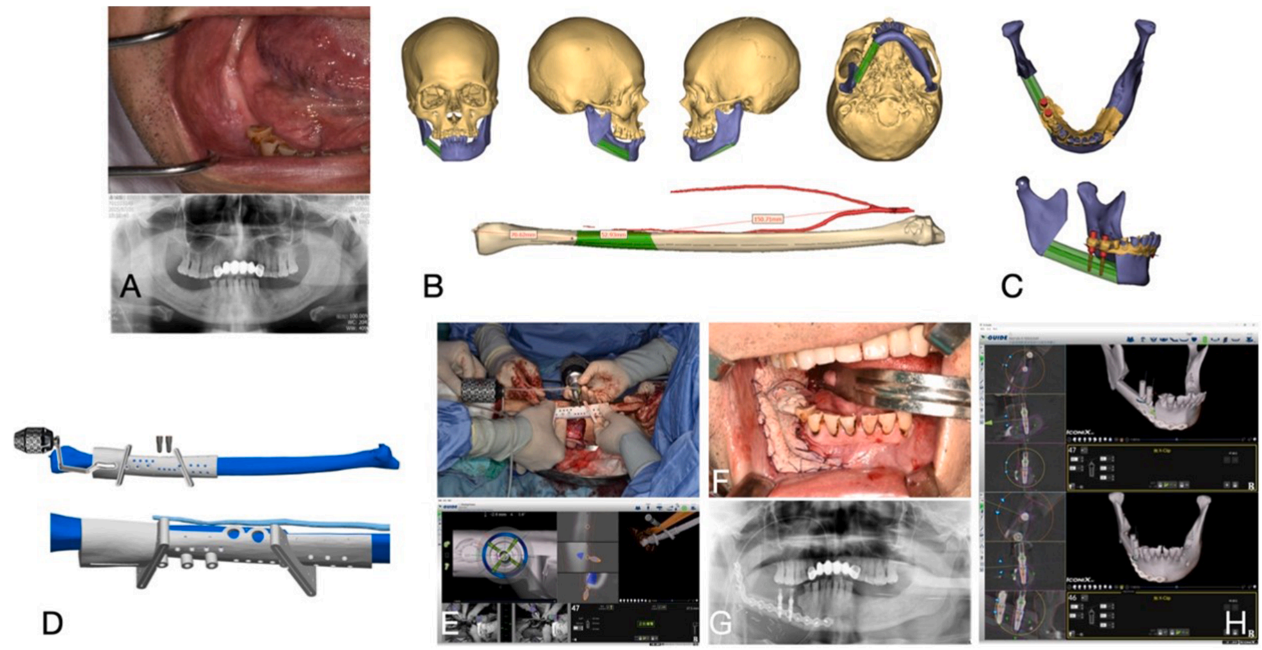

Figure 1 The jaw-in-a-day case and the digital workflow. (A) Intra-oral photography and the panoramic radiograph showing a stage II (cT2N0M0) squamous cell carcinoma of the right mandibular gingiva. (B) Computer-aided surgical simulation (CASS) planning protocol presenting a single-segment fibula reconstruction. (C) The CASS planning protocol presenting the diagnostic wax-up and placement of virtual implants. (D) Importing image and stereolithography (STL) objects for the dynamic navigation with X-Guide system (X-Nav Technologies, Lansdale, PA, USA). (E) The dynamic navigation of implant placement with the fibula guide assistance. (F) Intra-oral photograph of prosthesis connection and flap in setting. (G) The post-operative panoramic radiography showing the fibula bone and implants in place. (H) The post-operative cone-beam computed tomography (CBCT) and superimposition showing the acceptable surgical accuracy.

Jaw movement and occlusion were verified. Vascular anastomosis, prosthesis reconnection, and skin paddle inset were uneventful (Fig. 1F). The patient was transferred to the intensive care unit with the provisional prosthesis in place.

Results

The postoperative course was uneventful. The patient was discharged three weeks after surgery without the need for nasogastric tube feeding, and oral intake progressed smoothly without complications. A postoperative cone-beam computed tomography (CBCT) scan was obtained two months after surgery to allow quantitative assessment of implant placement outcomes (Fig. 1G and H).

To evaluate the implant placement accuracy, the post-operative CBCT dataset was superimposed onto the pre-operative virtual surgical plan. Deviations between the planned and actual implant positions were calculated according to the three standard parameters: angular deviation, platform depth deviation, and apical depth deviation (Fig. 1H). Our data regarding the three standard parameters were subsequently compared with the dynamic navigation data reported by Block et al.[7] in 2017 (Table 1).

The quantitative analysis demonstrated that all measured deviation parameters in this JIAD case fell within the reported ranges for dynamic navigation–assisted implant

Table 1 Accuracy of implant placement for the jaw-in-a-day reconstruction -Comparison of our data regarding the three standard parameters (angular deviation, platform depth deviation, and apical depth deviation) with the dynamic navigation data reported by Block et al.[7] in 2017.

Parameter	Present JIAD case 45	Present JIAD case 46	Dynamic navigation data reported by Block et al.[7] in 2017
Angular deviation (deg)	3.44	6.27	3.62 ± 2.73
Platform depth deviation (mm)	1.11	0.99	0.93 ± 0.60
Apical depth deviation (mm)	1.09	0.92	0.96 ± 0.66

Angular deviation: Angular discrepancy between the planned and actual implant axis Platform depth deviation: Linear discrepancy along the implant axis between the planned and actual platform positions.
Apical depth deviation: Linear discrepancy along the implant axis between the planned and actual apex positions.

placement in conventional (native bone) clinical settings. No clinically significant differences were found between the implant accuracy achieved in fibula flap reconstructions and that reported for dynamic navigation—guided implant placement in non-reconstructed jaws.

Discussion

The JIAD procedure represents a major advancement in functional mandibular reconstruction by enabling immediate dental rehabilitation following oncologic resection. Despite its clinical benefits, the precise implant positioning remains one of the most technically demanding components of this workflow, particularly in the context of fibula flap reconstruction.

Static implant guides, although widely adopted, are highly dependent on accurate guide seating on the fibula segment. Variations in muscle cuff thickness, soft-tissue bulk surrounding the harvested fibula, and minor positional discrepancies during guide fixation can introduce cumulative errors that adversely affect the implant accuracy and subsequent prosthetic outcomes.[8] These limitations may be amplified in the JIAD cases, where intraoperative conditions differ substantially from preoperative planning assumptions.

Dynamic navigation offers distinct advantages that directly address these challenges. The real-time intraoperative visualization enables continuous monitoring and adjustment of implant trajectory based on the actual spatial relationship between the surgical plan and intraoperative anatomy. In JIAD patients, the precise implant placement depends not only on the navigation system itself but also on strict adherence to a stepwise, CASS-based protocol, including the accurate cutting guide placement, fibula segment preparation, and intraoral transfer. Even when the overall clinical outcomes appear acceptable, deviation from any single step may result in substantial discrepancies in the implant positioning, potentially affecting the definitive prosthesis position and occlusal scheme.

In the present case, the dynamic navigation provided the intraoperative adaptability while preserving the predictability of the preoperative CASS workflow. The accurate implant positioning was achieved despite potential soft-tissue interference that could compromise static guide seating and stability. By integrating dynamic navigation into a JIAD protocol, we effectively combined the preoperative predictability of static surgical planning with the intraoperative flexibility of navigation-assisted control.

This hybrid approach may mitigate the inherent limitations of purely static guide—based workflows and enhance the reliability of implant placement in complex mandibular reconstructions. The comparable accuracy observed between this JIAD case and previously reported dynamic navigation outcomes in the conventional implant placement further supports the feasibility and potential clinical value of this strategy.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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