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DENTAL TECHNIQUE

Combining custom retraction, fiducial markers, and splinted implant scan bodies for mandibular complete arch implant scanning: A dental technique

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ABSTRACT

Intraoral scanning of a severely atrophic mandible remains challenging because of limited crestal landmarks, mobile soft tissues, and restricted scanner access. This dental technique describes a workflow that combines a patient-specific 3-dimensionally printed retractor, temporary parasymphyseal miniscrews as fiducial markers, and implant scan bodies (ISBs) splinted with an orthodontic elastomeric chain and flowable resin for a severely atrophic mandibular arch. The retractor improves exposure of the peri-implant mucosa, the miniscrews provide detectable landmarks for alignment, and the splinted ISBs help record interimplant relationships. (J Prosthet Dent xxxx;xxx:xxx-xxx)

The intraoral scanning of edentulous arches remains challenging despite advances in digital workflows for complete arch implant rehabilitation.[1–4] Accuracy is limited by arch morphology, lack of stable landmarks, long edentulous spans, and the mobility of perioral and lingual soft tissues.[4–8] These issues are greater in the mandible, where the absence of a palatal vault and interference from the tongue and sublingual tissues hinder scanner access and negatively affect stitching.[4,6,9] Several strategies have been proposed to improve accuracy, including optimized scanning paths,[10] different scan body application variables,[11–13] fiducial markers for stitching and dataset alignment,[14–16] and retractors to displace soft tissues.[17,18] However, commercially available retractors are not patient-specific. Splinting techniques have also been tested to reduce inaccuracies between adjacent implant scan bodies (ISBs),[19–21] although their benefit remains debatable and may depend on the clinical scenario, protocol, and intraoral scanning system.[13,19–24]

More recently, calibrated splinting intraoral scanning protocols have shown accuracy comparable with that of conventional splinted impressions and better than that of standard unsplinted digital approaches.[6,9,11,25,26] However, most have been validated in the maxilla, whereas solutions specifically designed for severely atrophic mandibles remain limited, despite the greater challenges of advanced resorption stages such as Cawood-Howell Class V.[27] In addition, calibrated splinting systems often require preliminary scans on scan bodies or individualized frameworks, which may increase cost, time, and technical complexity.[3,9,11,26]

To address this gap, the present dental technique describes a step-by-step intraoral scanning method for severely atrophic mandibular arches that combines a

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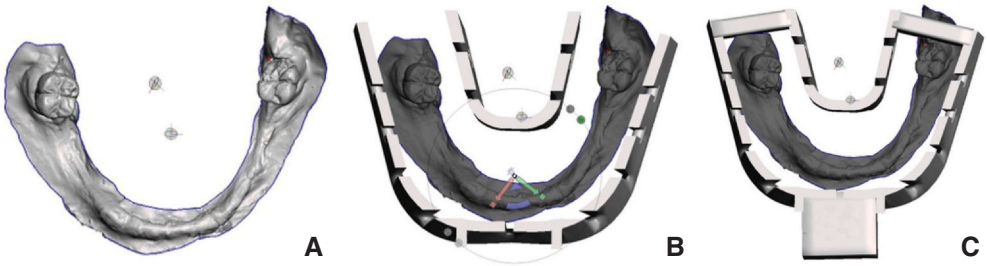


Figure 1. Workflow for design of custom complete arch retractor in freeware software program (Meshmixer v. 3.5; Autodesk Inc). A, Imported intraoral scan of atrophic mandible.; B, Adjustment and resizing of buccal and lingual flanges. C, Addition of posterior stops to complete custom retractor for intraoral scanning.

custom 3-dimensionally (3D) printed mandibular retractor, orthodontic miniscrews as temporary fiducial markers, and the direct intraoral splinting of scan bodies.

TECHNIQUE

The patient was treated in a private clinical setting. Written informed consent for treatment and the publication of anonymized clinical data and images was obtained. Ethical approval was not required because treatment was delivered as routine clinical care in accordance with the Declaration of Helsinki.

1. Import the virtual cast, made with an intraoral scanner (IOS) (Primescan 2; Dentsply Sirona), on the gypsum cast of an edentulous mandible into a software program (Meshmixer v. 3.5; Autodesk Inc) (Fig. 1A).
2. Load the custom retractor data (Supplemental File 1, available online) in standard tessellation language (STL) file format into Meshmixer (Fig. 1A). Adjust the flange height and width relative to the alveolar crest and floor of the mouth (Fig. 1B). Extend the distal pads to seat just anterior to the retromolar trigone (Fig. 1C). Finally, export the resized retractor as an STL file (Fig. 2A).
3. Prepare the STL file for 3D printing into a CAD software program (PreForm Nesting; Formlabs) and print it with a dedicated 3D printer (Form 4B; Formlabs) and sterilizable resin (Surgical Guide Resin; Formlabs). Orient the cast at 30 degrees to the build platform and place supports on nonbearing areas. After printing, wash the retractor in 99% isopropyl alcohol, dry it thoroughly with compressed air, and postpolymerize it at 60 °C.
4. Insert the printed retractor intraorally to verify its extension (Fig. 2B).
5. Administer plexus anesthesia in the peri-implant area using mepivacaine hydrochloride 20 mg/mL with adrenaline 1:100 000 (Scandonest 2%; Septodont). Then, place the mini conical abutments (Bionnovation LTDA) with the recommended torque (20 Ncm), followed by the miniconical abutment caps (Protection Cap 12007; Bionnovation).
6. Insert 2 self-drilling miniscrews (Ø1.4×8 mm; BioRay Biotech) into the anterior mandibular parasymphysis, avoiding the mental foramina; hand-tighten to primary stability.
7. Place light-polymerizing flowable resin (LC Block-Out Resin; Ultradent Products, Inc) over the miniscrew heads to create hemispherical domes of Ø3 to 4 mm and then light polymerize (Fig. 3A).
8. Seat the custom retractor with the posterior stops on the retromolar pads and the anterior handle at the midline, ensuring the isolation of the lips, cheeks, tongue, and sublingual tissues from the peri-implant mucosa. Then, intraorally scan the edentulous area and include the fiducial markers (Supplemental Video 1, available online).
9. Remove the miniconical abutment caps and place implant scan bodies (ISBs) (ANMUA-IO; Bioinnovation) with the recommended torque (10 Ncm) and verify complete seating.
10. Splint adjacent ISBs with a continuous orthodontic elastomeric chain (Dyna-Link 1-mm width; G&H Orthodontics) and then cut the excess with surgical scissors (Fig. 3B).[28]
11. Cover the chain with the light-polymerizing flowable resin to form a rigid, low-profile bar with an approximately uniform cross-section (Fig. 3C).
12. Verify passive clearance between the resin bar, surrounding soft tissues, and custom retractor while

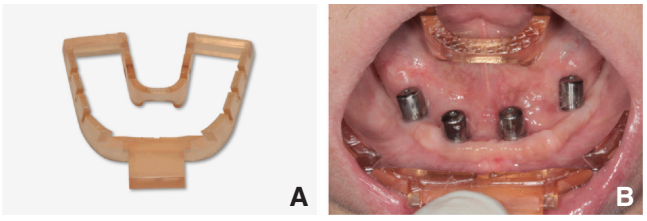


Figure 2. 3D printed custom retractor and intraoral application. A, 3D printed resin retractor. B, Intraoral positioning of custom retractor.

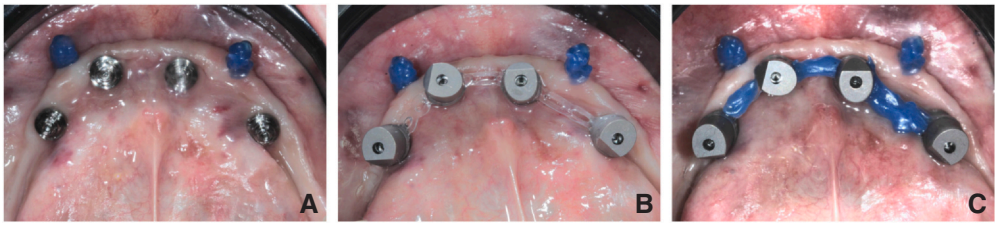


Figure 3. Splinting implant scan bodies with orthodontic miniscrews as references for scan alignment. A, Placement of orthodontic miniscrews covered with flowable resin to reduce reflection and improve scanning. B, Splinting of scan bodies with orthodontic elastomeric chain. C, Application of light-polymerizing flowable resin over elastomeric chain to splint implant scan bodies.

maintaining complete exposure of the ISB indexing surfaces. If interference is detected, reduce the resin until passive clearance is obtained (Fig. 4). Then, intraorally scan the splinted ISBs and the fiducial markers with the retractor still seated.

13. Import both scans into the CAD software program (Sirona Connect; Dentsply Sirona). Make an initial landmark registration by selecting 3 corresponding points on the resin-coated fiducial domes in both datasets and then complete a local surface-based refinement restricted to the fiducial marker surfaces and adjacent stable tissues (Fig. 5).

DISCUSSION

The presented method includes 3 essential components: a patient-specific retractor, orthodontic miniscrews as fiducial markers, and ISBs splinted with an elastomeric chain (Supplemental Fig. 1, available online). The custom retractor improves scanner access and visibility by isolating the tongue, cheeks, and lips. However, unlike commercially available retractors, the file provided with this technique can be modified in a freeware software program (Meshmixer) to adapt it to different mandibular dimensions. The device is printed in a sterilizable resin, allowing reuse. The use of orthodontic miniscrews as fiducial markers is consistent with previous digital complete arch workflows.[14,15] In the present technique, 2 parasymphyseal miniscrews provide bilateral anterior landmarks away from the ISBs; 3- to 4-mm hemispherical resin domes improve detectability, and a low-profile splint preserves ISB visibility while limiting tissue or retractor interference. Contraindications include inadequate parasymphyseal bone, proximity to the mental foramina or other anatomic structures, active local infection, and patients who decline the placement of temporary anchorage devices. Although miniscrews require local anesthesia, placement is performed concurrently with multiunit abutment insertion. Splinting of ISBs has been validated for improving complete arch scan accuracy.[11,25,26] In this protocol, an elastomeric chain and flowable resin create a rigid scan-visible bar directly intraorally. Unlike prefabricated calibration systems, this approach avoids additional scans, appointments, and custom frameworks,[9,11,26] potentially reducing cost, time, and technical complexity. Compared with splinted impressions, the present workflow is more digitally dependent and supported by less direct comparative evidence.[19,25] Compared with unsplinted digital scans, it requires temporary miniscrews, a custom retractor, and

Figure 4. Frontal view of splinted scan bodies and orthodontic miniscrews as fiducial markers for scan-data alignment.

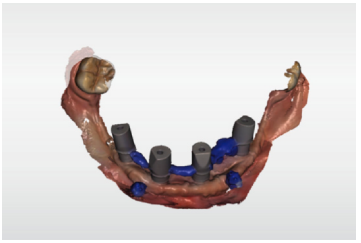
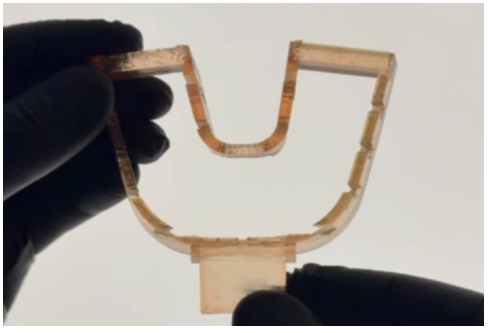


Figure 5. Digital alignment of scan data from splinted scan bodies and peri-implant soft tissues.



Supplemental Video 1. A video clip is available online. Supplementary material related to this article can be found online at doi:10.1016/j.prosdent.2026.05.005.

constrained dataset alignment; however, these additional steps may improve soft-tissue control and provide stable landmarks in severely atrophic mandibular arches.[11,24,25] Compared with calibrated splinting frameworks, this technique may reduce reliance on preliminary ISBs scans or individualized laboratory-made devices, but it still requires familiarity with digital alignment procedures.[6,9,11,26] Limitations include the need for stable fiducial markers, possible perception of invasiveness, familiarity with CAD alignment procedures, and limited clinical validation.

SUMMARY

This dental technique describes a workflow for the complete arch scanning of a patient with a severely atrophic mandible that combines a patient-specific 3D printed retractor, temporary parasymphyseal miniscrews used as fiducial markers, and the intraoral splinting of implant scan bodies. This combination enhances soft-tissue displacement and supports dataset alignment.

APPENDIX A. SUPPORTING INFORMATION

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.prosdent.2026.05.005.

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