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A NOVEL METHOD FOR RECORDING CENTRIC RELATION IN DIGITAL DENTURE WORKFLOW : A DENTAL TECHNIQUE

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Abstract

Accurate centric relation (CR) recording is crucial for successful complete denture fabrication. With the digitalization of denture fabrication, it is essential to retain the accuracy while improving efficiency. Yet, existing digital workflows often require repeated design and printing of tracer components for each patient. This study presents a hybrid technique which is an approach to enhance Gothic arch tracing using a 3D-printed CAD-based tracer attachment of a conventional intraoral tracerThis digital workflow utilizes intraoral scanning data to design custom denture base with tracing attachments, which is 3D- printed and can be attached to the conventional intraoral tracer, minimizing 3D printing and simplifying the process. Despite technological advancements, current digital methods remain limited by cost and adaptability. This technique bridges conventional and digital workflows, reducing chairside time while maintaining precise, repeatable CR records.

Keywords: digital denture, centric relation recording, gothic arch tracing

Introduction:

Traditionally, conventional complete dentures (CD) were the standard treatment for an edentulous condition. CD have provided reliable rehabilitation for decades; however, the process is time-consuming and requires multiple clinical appointments, extensive laboratory procedures, and physical storage of records.[1] Digital dentures were introduced in 1994, and their protocols continue to evolve with advances in scanning, design, and manufacturing technologies.[2] Centric relation (CR) and vertical dimension of occlusion (VDO) are critical determinants of successful complete denture outcomes. According to the Glossary of Prosthodontic Terms, CR is the maxillomandibular relationship, independent of tooth contact, in which the condyles articulate with the thinnest avascular portion of their respective discs with the complex in an anterior-superior position against the slopes of the articular eminences; this position is clinically discernible when the mandible is directed superiorly and anteriorly.[3] In both conventional and digital workflow, it is essential to record CR in a repeatable, accurate, and verifiable manner for functionally stable complete denture.

Among the various methods of recording CR, Gothic arch tracing stands out for its clinical reliability, as it produces a visible arrow-point

tracing that indicates the apex of mandibular movement and simultaneously records centric, lateral, and protrusive movements.[4] Conventional workflows are now gradually transitioning to digital methodologies. It incorporates, intraoral scanning, 3-Dimensional (3D) printing, and Computer Aided Designing/ Computer Aided Milling (CAD/CAM) systems. It can be complemented by optical jaw-tracking systems, that digitally record mandibular motion and maxillomandibular relationships.[5] However, these innovations still face challenges, including procedural complexity, cost, and the need for digital proficiency. The current digital CR recording methods lack universally validated, cost-efficient, and adaptable protocols for routine clinical use.

Present article introduces a hybrid technique that utilizes a reusable Standard Tessellation language (STL) file of the tracer attachment combined with a conventional intraoral Gothic arch tracer. The method integrates intraoral scan data to design custom denture bases with standard tracer attachments, minimizing repeated printing and streamlining the digital workflow. By combining the clinical reliability of conventional Gothic arch tracing with the efficiencies of digital design, the limitations of existing systems are addressed. This technique balances clinical reliability with digital efficiency.

Procedure:

Step 1: Maxillary and mandibular edentulous arches are scanned using an intraoral scanner (Medit i500, Medit Corp., South Korea) to obtain baseline digital casts (Fig. 1).

Step 2: Putty-consistency elastomeric impression material (3M Express XT VPS Impression Material, 3M ESPE, Germany) is loaded on a triple tray to record an arbitrary CR at a predetermined VDO, and this record is scanned to digitally orient the maxillary and mandibular arches in arbitrary centric relation (Fig. 2).

Step 3: The aligned scan data are imported into CAD software (Exocad DentalCAD, Exocad GmbH, Germany) to design custom trays with occlusal rims for both arches.

Step 4: The tracer attachment of the conventional intraoral Gothic arch tracer (Bio Tracer FB, Bio-Art, Brazil) is scanned to obtain an STL file, which is stored for repeated use in multiple cases.

Step 5: Custom maxillary and mandibular denture bases with occlusal rims are digitally designed in the CAD software, using the oriented digital casts as the reference.

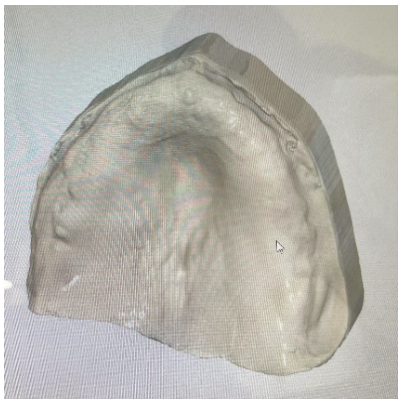
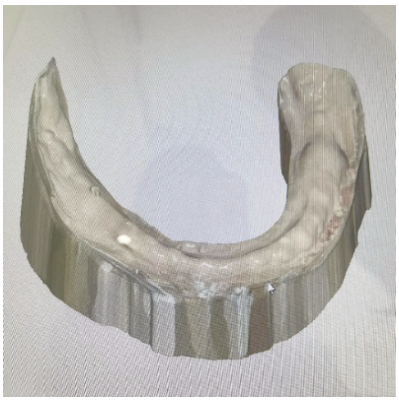


Fig. 1. Maxillary and mandibular intraoral scans of edentulous arches (Step 1).



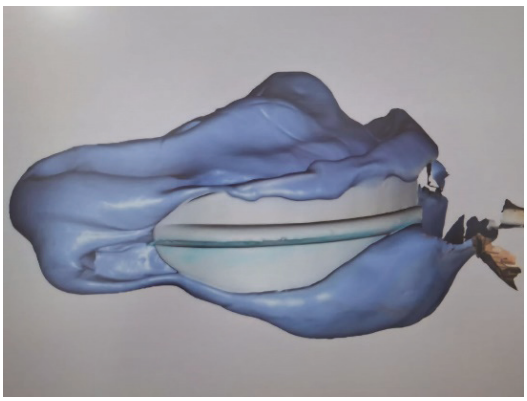


Fig. 2. Scan of arbitrary centric relation bite recorded using stock triple tray at predetermined VDO (Step 2).

Step 6: Thus, the STL file of the tracer attachment (approximately 5.0±0.1 mm thickness) is positioned on the maxillary and mandibular occlusal rims in the design software to create a standardized site for attachment of the conventional intraoral tracer (Fig. 3). The position of the tracer is verified by digitally superimposing it over the attachment.

Step 7: The denture bases with integrated tray and tracer-attachment design are 3D printed using a resin printer (AccuFab-L4K, Shining 3D, China) with a 50-μm layer thickness. These printed bases serve as special trays for definitive impression making and for supporting the intraoral tracer during CR recording.

Step 8: The printed maxillary and mandibular trays (each with integrated tracer attachment sites) are tried intraorally and adjusted for fit as needed. A definitive impression is made using the openmouth technique with light-body elastomeric impression material (3M Express™ XT Light Body, 3M ESPE, Germany) (Fig. 4). The final impression shall be done after border molding with heavy-body material, when required. The trays now contain definitive impressions, accurately capturing intraoral features for subsequent CR recording.

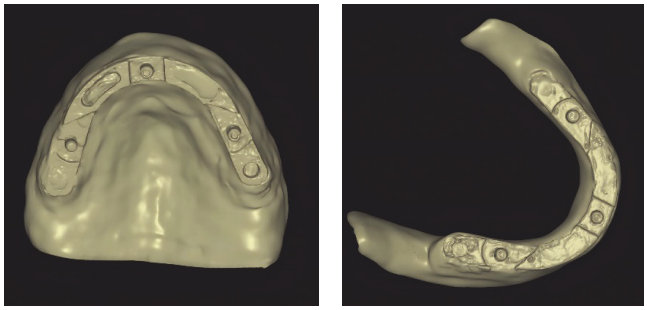


Fig. 3: STL file of tracer attachment oriented on CAD-designed custom trays with occlusal rims. The slots are oriented to enable attachment of the conventional intraoral tracer (Step 6).

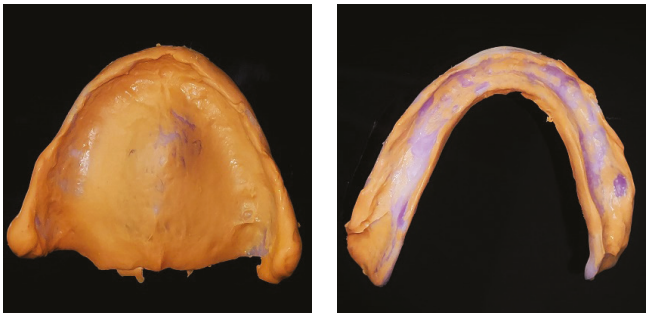


Fig. 4. Definitive maxillary and mandibular impressions made using open-mouth technique in printed trays with integrated tracer attachment sites (Step 8).

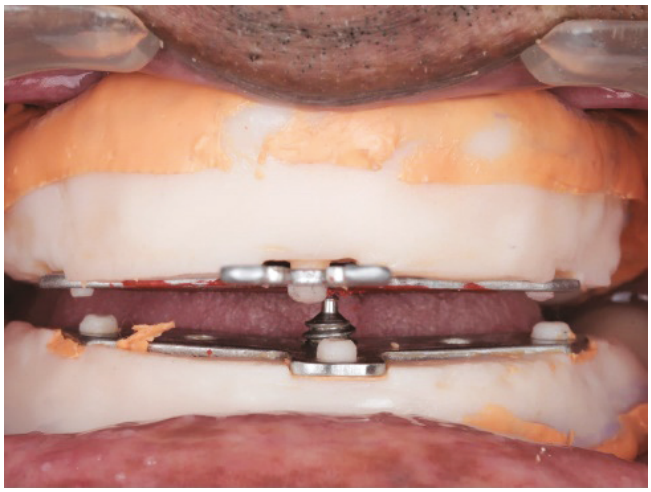


Fig. 5A. Conventional intraoral Gothic arch tracers attached to integrated tracer sites on maxillary and mandibular trays containing definitive impressions (Step 9).

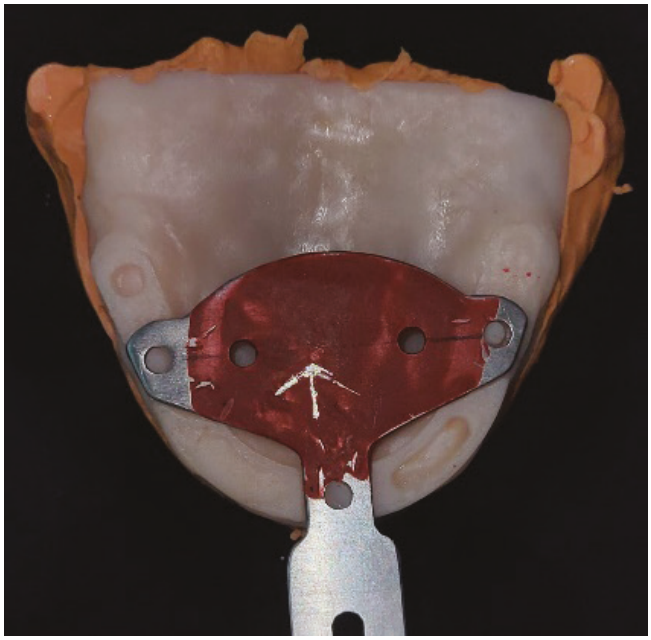


Fig. 5B. Gothic arch tracing completed with centric point marked and verified for repeatability (Step 9).

Step 9: The pre-determined VDO is verified by placing the metal bite rims provided with the Bio Tracer FB (Bio-Art, Brazil) over the tracer attachment sites, along with verification through phonetics. With the definitive impressions intact in both maxillary and mandibular trays, conventional intraoral Gothic arch tracers are attached to the integrated tracer attachment sites. The trays are seated intraorally (Fig. 5A). The patient is guided to perform protrusive and lateral movements to obtain a Gothic arch tracing, and the centric point is marked and verified for repeatability (Fig. 5B).

Step 10: After recording CR, the maxillary and mandibular printed bases with definitive impressions and tracer components are scanned using a laboratory scanner. The definitive impression-based casts and the verified CR position are transferred to a compatible virtual articulator (Stratos 200, Ivoclar, Liechtenstein) within the CAD software to design the definitive complete dentures according to the recorded mandibular dynamics.

Discussion

CR is crucial for complete denture treatment because it provides a stable, repeatable reference position for developing occlusion in patients who lack proprioceptive guidance from natural teeth.[6] The methods for recording CR have evolved over time with changes in biologic understanding and technological advances, yet accurate and reproducible registration remains a key determinant of denture success.[7]

The fundamental concepts employed in this proposed workflow is similar to established BPS principles. The maxillary and mandibular arches are scanned and oriented using an arbitrary centric record at a predetermined VDO, and the data are stored digitally for easy communication and duplication or modification of dentures when required in the future.[8] A reusable STL file of the tracer attachment for a conventional intraoral Gothic arch tracer is incorporated into the design, allowing precise and cost-effective CR recording while reducing repetitive design and printing of tracer components. By combining definitive impression making and CR recording within the same appointment, the approach reduces the number of visits and laboratory steps, which can benefit patients with limited access or mobility.[8] The definitive impression captures areas that may be difficult to record accurately with intraoral scanning alone, and the conventional intraoral tracer is then used to record centric and eccentric mandibular movements, with the Gothic arch tracing providing visual confirmation and repeatability of the centric position.

Optical jaw-tracking systems record mandibular motion in three dimensions and transfer it directly to virtual articulators.[9] These systems provide detailed dynamic records but require specialized equipment, software integration, and calibration. This increases cost and technique sensitivity. In contrast, this hybrid technique uses widely available CAD/CAM and 3D printing with a familiar Gothic arch tracer workflow. This makes it more accessible for clinicians transitioning to digital dentures.

Other digital techniques custom-print new trays and tracing assemblies (tenon-and-mortise joints) for each patient, following BPS concepts.[10] These workflows require multiple printed components and additional steps for jaw relation transfer. This technique uses reusable STL tracer attachment integrated into the denture base design. This eliminates repeated printing of tracer parts. It saves time and materials while maintaining visual CR verification through the Gothic arch tracing, making it suitable for resource-limited settings. The novelty of the

technique lies in its digital implementation and workflow optimization.

A key limitation of the present technique is the use of a model resin that is not certified as a long-term intraoral biocompatible material. In this report, the resin was used only for short-term intraoral procedures (definitive impression making and CR tracing) and no adverse reactions were observed, but this still represents a limitation. Future work should validate dedicated biocompatible tray resins such as Arma Dental 3D Printing Resin (Arma Dental Production Systems, Turkey) or Formlabs Custom Tray Resin (Formlabs Inc., USA) as alternatives to model resins.[11]

Additionally, successful application of the method requires familiarity with digital design, careful calibration of the tracer attachment to avoid errors in vertical dimension, and validation of the workflow across larger samples and different operators. Future work could integrate intraoral digital CR recording withdynamic mandibular tracking technologies like Metismile MR (Shining 3D, China). Further studies comparing this hybrid approach with fully digital jaw-tracking systems and other digital denture protocols could help refine indications, quantify accuracy, and standardize its use in routine clinical practice.

Conclusion

This hybrid technique integrates conventional Gothic arch tracing with digital denture design for accurate CR recording. The reusable STL file of the tracer attachment eliminates printing multiple components while maintaining clinical reliability. It provides a cost-effective solution for digital complete denture workflows in resource-limited settings.

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List of Abbreviations

Abbreviation	*Definition*
CR	Centric Relation
CD	Complete Denture
DD	Digital Denture
VDO	Vertical Dimension od Occlusion
3D	3-Dimensional
STL	Standard Tessellation language
CAD	Computer Aided Designing
CAM	Computer Aided Milling