JPD DIGITAL

CLINICAL REPORT

Innovative subtractive production of a digital removable complete denture from start to finish: a JPD Digital video presentation

Nelson R. F. A. Silva, DDS, MSc, PhD[a] and Eric D. Kukucka, DD[b]

ABSTRACT

This JPD Digital video presentation presents the clinical treatment from start to finish in which a dual-shaded bi-coloured monolithic disk was used for the fabrication of an immediate digital complete denture followed by the delivery of a definitive digital complete denture. The treatment plan included extraction of the remaining maxillary and mandibular teeth followed by an esthetic evaluation with digital smile design. The digital definitive complete dentures were milled from a monolithic dual-shaded disk. (J Prosthet Dent 2022;127:1-5)

The quality of removable complete dentures and patient satisfaction can be improved by adding standardized and more predictable steps through computer-aided design and computer-aided manufacturing (CAD-CAM). CAD-CAM for complete dentures were first described in 1994[1] but have only become popular since 2012,[2-6] with improvements within the software programs creating the possibility of different workflows and manufacturing strategies, combined with the development of new material concepts.

An innovative subtractive manufacturing method for digital complete dentures has recently been developed (Ivotion Monolithic; Ivoclar Vivadent AG) (Fig. 1A). The method consists of a single disk that is milled at a single time. The milling disk combines highly cross-linked polymethyl methacrylate (PMMA) dual-shaded tooth and denture base materials, promising to provide a rapid and predictable monolithic milling solution that eliminates the manual tooth-bonding process.

The dual-shaded monolithic concept uses shell geometry technology based on data gathered from an extensive range of successful complete denture treatments. The shell geometry's 3-dimensional dental arch structure (Fig. 1B) defines the transition between the tooth and base sections of the milling disk for a stress-free, high-strength, homogeneous transition (Fig. 1C). The CAD design process is integrated into a CAD software program (Dental System 2020; 3Shape A/S) (Fig. 1D), allowing full patient-specific customization of the removable complete denture to meet patient needs. The tooth library and coordinated shell geometry offer CAD design strategies for a wide range of jaw shapes and sizes and even the ability to customize and morph individual teeth.

CLINICAL REPORT

A 53-year-old man attended the author's clinic looking for improvement in his smile. He was diagnosed with generalized chronic periodontitis with more than 70% of periodontal attachment loss. The uncertain periodontal prognosis and his limited finances led to a treatment plan that included extraction of the remaining maxillary and mandibular teeth and provision of digital immediate removable complete dentures (Fig. 2) followed by digital definitive complete dentures after the extraction sites had healed.

[a]Associate Professor at Federal University of Minas Gerais (UFMG), Brazil; and Acted as Assistant and Associate Professor at New York University 2002-2012.
[b]President of The Denture Center, Ontario, Canada; and 2nd Certified Global Instructor of Dr Abe's SEMCD Methodology; and Faculty Member of the Digital Dentistry Institute; and Practicing Denturist and Alpha and Beta Tester for Major Industry Development in Digital Denture Technology.

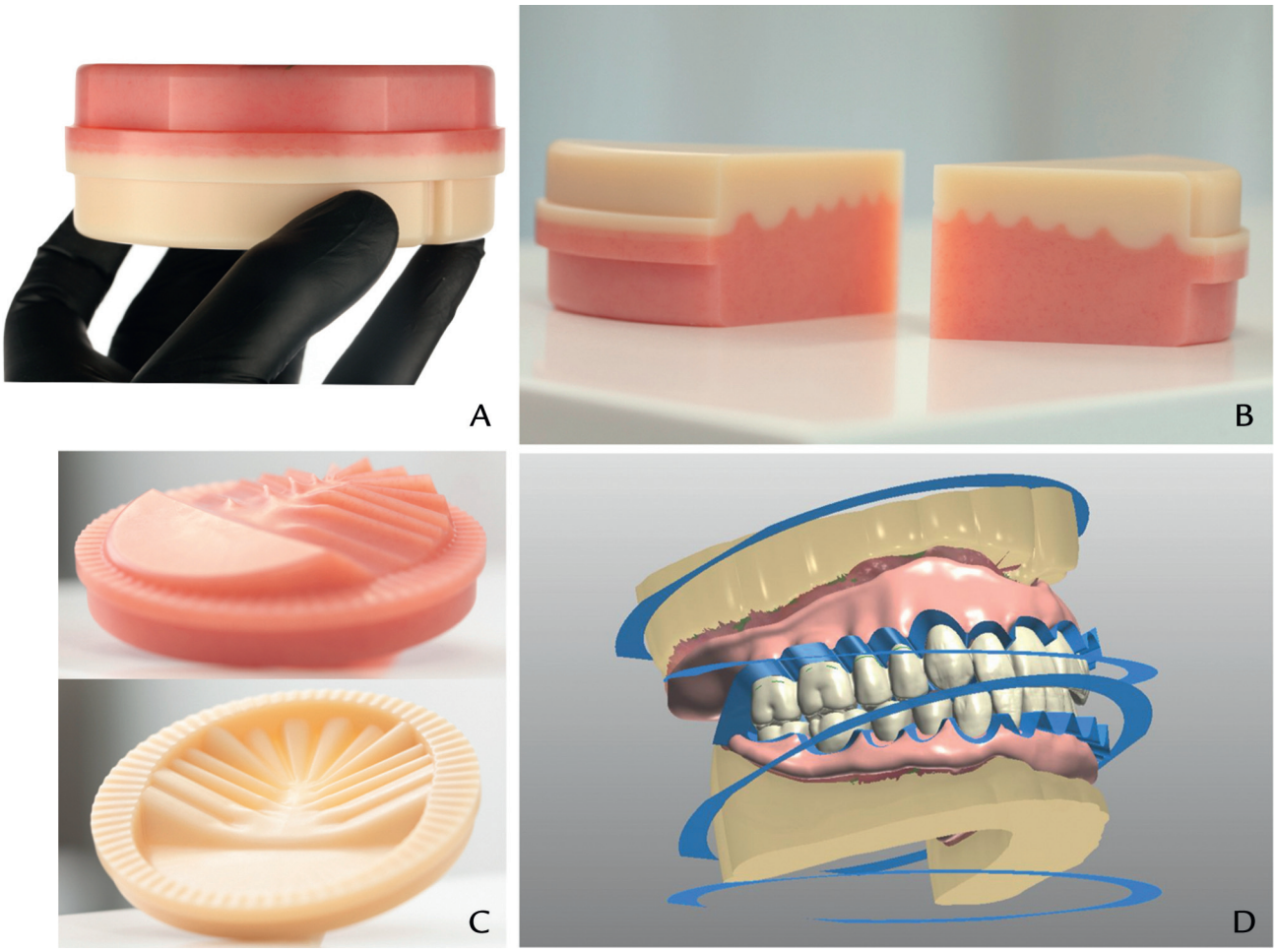

Figure 1. A, Complete denture disk with gingival and tooth colored polymethyl methacrylate (Ivotion Monolithic; Ivoclar Vivadent AG). B, Cross section of disk showing transition from pink base to teeth. Note papilla architecture and smooth transition to teeth part of disk. C, inner aspect view of disk showing the shell geometry technology used to define papilla and tooth morphology. D, Shell geometry technology incorporated into the 3Shape Dental System CAD software program.

The initial clinical steps included two-dimensional (2D) photographs for smile design (TRIOS Design Studio; 3Shape A/S) (Fig. 3) followed by intraoral scanning (TRIOS4; 3Shape A/S) of both arches and of the occlusal relationship. From the outcome of the smile design and alignment of the intraoral scans, the digital immediate complete dentures were designed (Dental System 2020; 3Shape A/S). After the designs had been completed, disks with shell geometry technology and base shade preference and tooth shade A1 were selected and positioned inside a milling unit (PrograMill 7; Ivoclar Vivadent AG). After the milling step, the digital immediate complete dentures were textured and polished. The remaining maxillary and mandibular teeth were extracted, and the digital immediate complete dentures were delivered.

After 6 months of healing, the digital definitive complete dentures were produced with the reference denture technique[7-10] using scans of the digital immediate complete dentures as the references for the design. Necessary enhancements for optimal function, esthetics, and phonetics were made.

The digital definitive complete dentures were designed from an alignment of the copy denture scans and smile design for the appropriate tooth positioning (Fig. 4A). After the digital definitive complete denture designs had been finalized, maxillary and mandibular trial dentures were 3D printed (Anycubic Photon; Anycubic) and evaluated clinically for function, esthetics, and phonetics. Upon approval of the 3D printed trial dentures, the maxillary and mandibular definitive digital dentures were milled (PrograMill7; Ivoclar Vivadent AG), textured, polished, and delivered, rehabilitating a periodontally compromised dentition, providing function, esthetics, and phonetics (Fig. 4B, 4C).

Figure 2. Preoperative condition. A, Intraoral view. B, Full-face view.

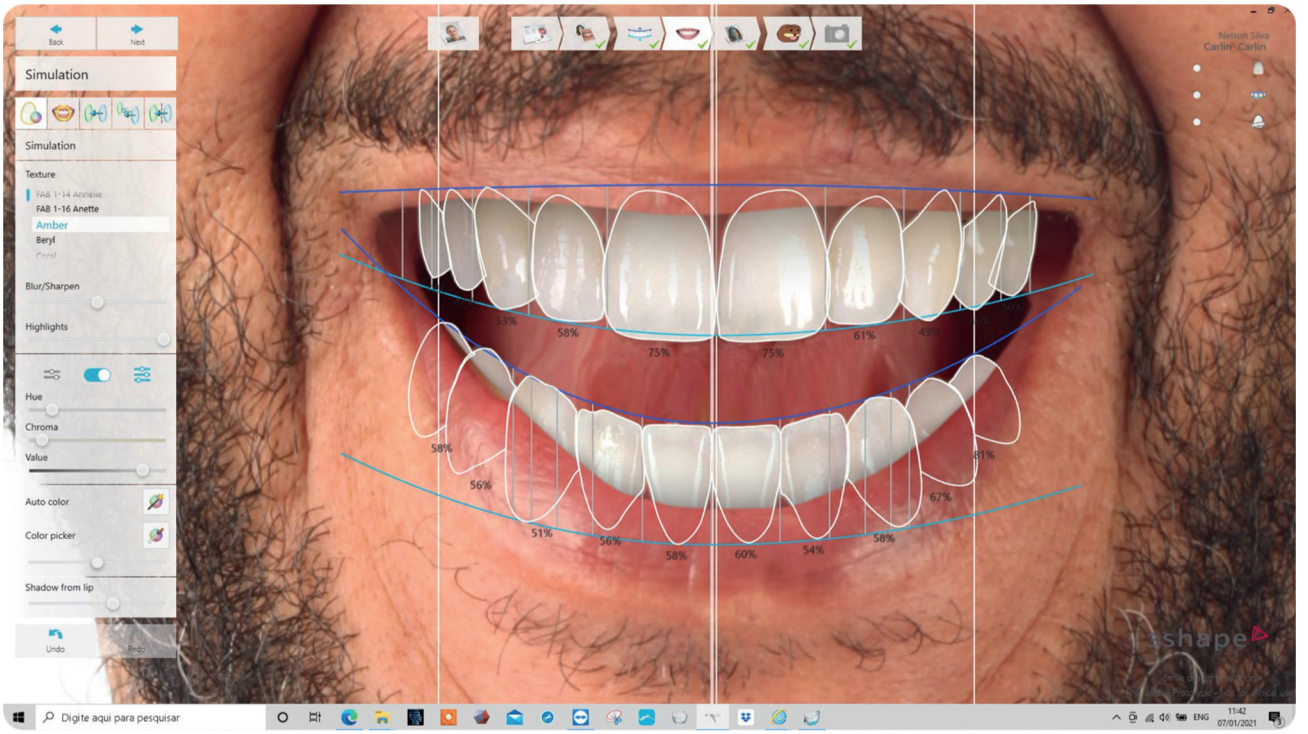

Figure 3. Smile design simulation from maxillary and mandibular tooth library.

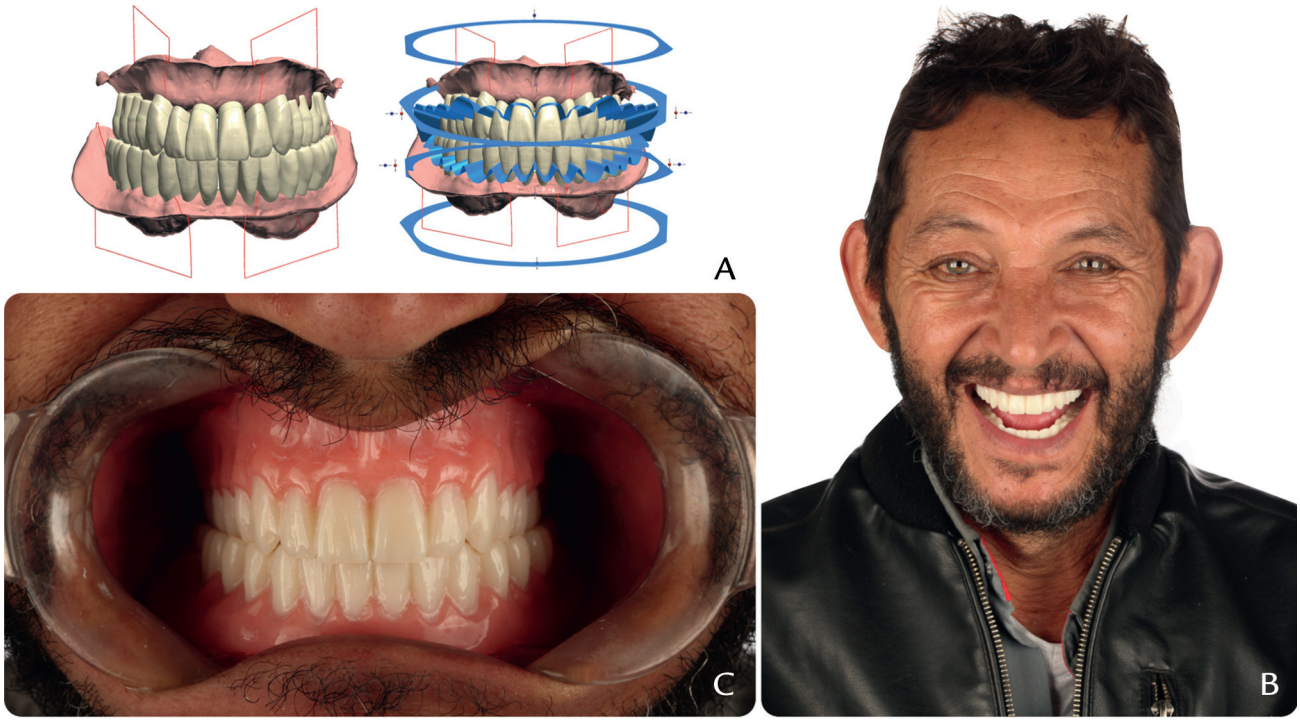

Figure 4. A, Definitive computer-aided design and shell geometry (*blue rings*) positioned for definitive production. B, Intraoral image of digital definitive complete dentures. C, Full-face view after digital defective complete dentures delivered.

DISCUSSION

Digital immediate and definitive complete dentures produced from intraoral scans of periodontally compromised teeth bring a significant advantage for the treatment planning and delivery of outstanding complete dentures. Together with an optimized design, the single subtractive milling process presented provides an efficient manufacturing process with the opportunity to customize esthetics by using smile design aligned with the CAD design step and after the milling process.

Disadvantages of the workflow include positioning the shell geometry during the CAD process. The architecture of the gingival papilla cannot be modified; therefore, the height of the papilla peaks is not adjustable. Moreover, as the shell geometry has static papilla architecture, the positioning of the disk for the tooth and base design can lead to an undesirably thin milled base, with tooth color being visible through the base, particularly at the tuberosity and retromolar pad regions. For patients for whom the monolithic disk could not be used based on these limitations, the alternative approach is to mill a pink base (Ivotion Base; Ivoclar Vivadent AG) and the teeth (Ivotion Dent; Ivoclar Vivadent AG) separately to then bond them together.

Digital denture systems offer flexible workflow options, and digital denture systems can improve communication between the dentist and the dental laboratory technician. Although patient selection is important, fabricating milled complete dentures from prepolymerized PMMA disks result in a digital removable complete denture that is highly dense, stable, and precise. The monolithic disk is homogenous with minimal porosity, which may improve resistance to bacterial and fungal infiltration into the resin. Patient satisfaction should be high, as the process requires fewer appointments and provides more accurately fitting prostheses. Clinical trials are necessary to evaluate the biomechanical performance and biofilm accumulation of the dual-shaded monolithic disk dentures presented in this JPD Digital video presentation.

REFERENCES

1. Maeda A, Minoura M, Tsutsumi S, Okada M, Nokubi T. CAD/CAM system for removable denture. Part I: fabrication of complete dentures. Int J Prosthodont 1994;7:17-21.
2. Kawahata N, Ono H, Nishi Y, Hamano T, Nagaoka E. Trial of duplication procedure for complete dentures by CAD/CAM. J Oral Rehabil 1997;24:540-8.
3. Busch M, Kordass B. Concept and development of a computerized positioning of prosthetic teeth for complete dentures. Int J Comput Dent 2006;9:113-20.
4. Sun Y, Lü P, Wang Y. Study on CAD&RP for removable complete denture. Comput Methods Programs Biomed 2009;93:266-72.

5. Kanazawa M, Inokoshi M, Minakuchi S, Ohbayashi N. Trial of a CAD/CAM system for fabricating complete dentures. Dent Mater J 2011;30:93-6.
6. Inokoshi M, Kanazawa M, Minakuchi S. Evaluation of a complete denture trial method applying rapid prototyping. Dent Mater J 2012;31:40-6.
7. Maragliano-Muniz P, Kukucka ED. Incorporating digital dentures into clinical practice: flexible workflows and improved clinical outcomes. J Prosthodont 2021;30:125-32.
8. Kurahashi K, Matsuda T, Goto T, Ishida Y, Ito T, Ichikawa T. Duplication of complete dentures using general-purpose handheld optical scanner and 3-dimensional printer: introduction and clinical considerations. J Prosthodont Res 2017;61:81-6.
9. Ammoun R, Bencharit S. Creating a digital duplicate denture file using a desktop scanner and an open-source software program: a dental technique. J Prosthet Dent 2021;125:402-6.
10. Takeda Y, Lau J, Nouh H, Hirayama H. A 3D printing replication technique for fabricating digital dentures. J Prosthet Dent 2020;124:251-6.

Corresponding author:
Dr Nelson R.F.A. Silva
Federal University of Minas Gerais (UFMG)
Gerais
BRAZIL
Email: nrfa.silva@gmail.com

Acknowledgments
The authors thank the JPD Digital Advisory Board for the opportunity to publish the first JPD Digital video presentation. Special acknowledgment goes to Prof Carlo Marinello for the enormous and generous contribution during the development of the overall content for this pioneer project.
Support to develop the JPD Digital video presentation was provided by Ivoclar Vivadent AG and 3Shape A/S.

https://doi.org/10.1016/j.prosdent.2021.12.002