From 2D to

Complete Digital Workflow in Interdisciplinary Dentistry

Christian Coachman, DDS, CDT
Marcelo Alexandre Calamita, DDS, MSD, PhD
Newton Sesma, DDS, MSD, PhD

Dr. Christian Coachman will present "The Virtual Lab and the Complete Digital Workflow" on Friday, April 29, at AACD 2016 Toronto. In this course, he will introduce the new generation of interdisciplinary software that allows clinicians to develop facial analysis to 3D smile design, interdisciplinary planning, and fabrication of everything needed to restore a smile.

Abstract

The use of digital technology is becoming more common in clinical dentistry. A general knowledge of the scope of these resources can help clinicians to develop more precise treatment plans and achieve more predictable clinical results. This article discusses novel ways to integrate patient data into a digital workflow in interdisciplinary dentistry. A complete digital workflow that increases the predictability of the clinical procedures and relates the initial project to the final outcome is presented.

Key Words: esthetic dentistry, dynamic smile analysis, video documentation, smile design, smile frame

Virtual planning uses patient photographs and videos to digitally design a new smile to facilitate communication between the interdisciplinary team and the patient.

Introduction

The digital workflow, with its ability to improve diagnosis and render more predictable treatment plans than conventional workflows,[1] is being increasingly used in many areas of clinical dentistry. It also allows standardization of quality due to industrially controlled manufacturing process and so tends to reduce the number of consultations. Furthermore, the digital workflow can be more efficient than the conventional workflow in terms of cost/time[2] and shows high patient acceptance.[3,4]

Two main topics related to digital workflow have been reported in the literature: virtual planning and execution with digital CAD/CAM methods. [5,6] Virtual planning uses patient photographs and videos to digitally design a new smile[7] to facilitate communication between the interdisciplinary team and the patient. Digitally milled models,8 virtual articulators,[9] and planning software complement the resources for an evaluation and interpretation of clinical data to help predict patient outcomes and modulate expectations. New integrated technologies such as intraoral scanners,[10,11] digitally produced surgical guides,[12-14] and CAD/CAM methods and materials[15-17] enable the digital execution of rehabilitative therapies with greater predictability and security.

The goals of this article are as follows:

- Present an interdisciplinary software platform that not only produces CAD/CAM restorations and devices, but also helps in the challenging interdisciplinary decision-making process.
- Show a simple workflow that starts with a two-dimensional (2D) smile frame that is overlapped onto three-dimensional (3D) orthodontic, orthognathic, implant, and restorative software.
- Link smile design into functional interdisciplinary treatment plans.
- Present a complete digital workflow that increases the predictability of the clinical procedures and relates the initial project to the final outcome.

Video/Photo Documentation

In dentistry it is very important to analyze specific instances of facial expression (e.g., lips at rest, height of the smile line, lip shapes, integration of facial and dental midline, lip support, soft tissue display, buccal corridor, and facial profile) to understand the dentofacial disharmonies and make clinical decisions. All these analyses can be distorted if we look only at photographs. Videos can capture the specific view with slightly different angles and can be transformed into photos by pausing the video and making a print screen of the correct angle. The facial analysis through video should guide the smile design process, which will be done over 2D and 3D static images **(Fig 1)**.

Figure 1: Smartphone video documentation.

"By using slide presentation software programs as well as cloud sharing and group messaging apps, all the involved professionals can... communicate effectively online."

Integrative Technology

The main goal of the DSD technique (Digital Smile Design; São Paulo, Brazil) on the computer is to adjust the photographs from the three main views (12 o'clock, frontal, and occlusal) **(Fig 2)** with each other, assisted by the digital ruler, and to add the lines and drawings that will create the smile frame, always based on the video analysis. This frame **(Fig 3)** is useful extra information that, together with the conventional documentation of the patient (e.g., x-rays, models, medical history, clinical exam, perio chart), helps to facilitate a better decision-making process and interdisciplinary interaction.

Team Communication

Sharing the patient's video and smile frame slide presentation with the specialists who will be involved with the case allows the whole team—even those team members who were not present at the first appointment with the patient—to become familiar with the case. By using slide presentation software programs as well as cloud sharing and group messaging apps, all the involved professionals can have access to the information, each in his or her own time, and communicate effectively online (online asynchronous communication) **(Fig 4)**. With this protocol it is possible to overcome two of the main challenges of interdisciplinary dentistry: difficulty in geographically distant team members being able to communicate at the same time and lack of common vision among the interdisciplinary team regarding the case's final ideal outcome.

Figure 2: The 2D/3D digital workflow.

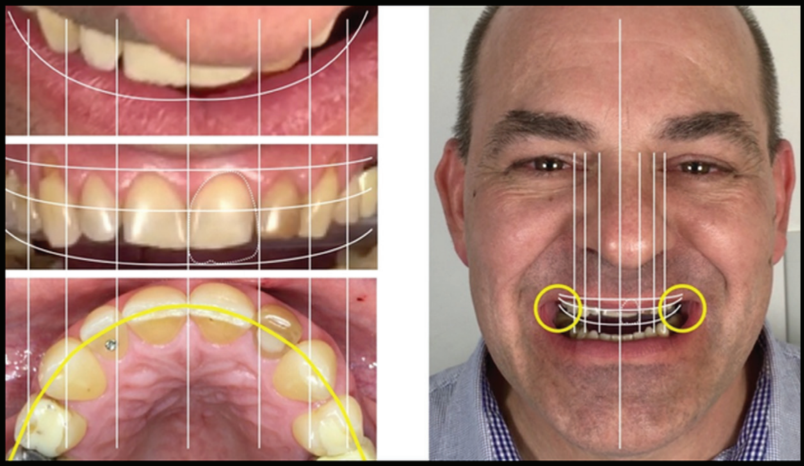


Figure 3: Smile frame on the three views of frontal, occlusal, and 12 o'clock.

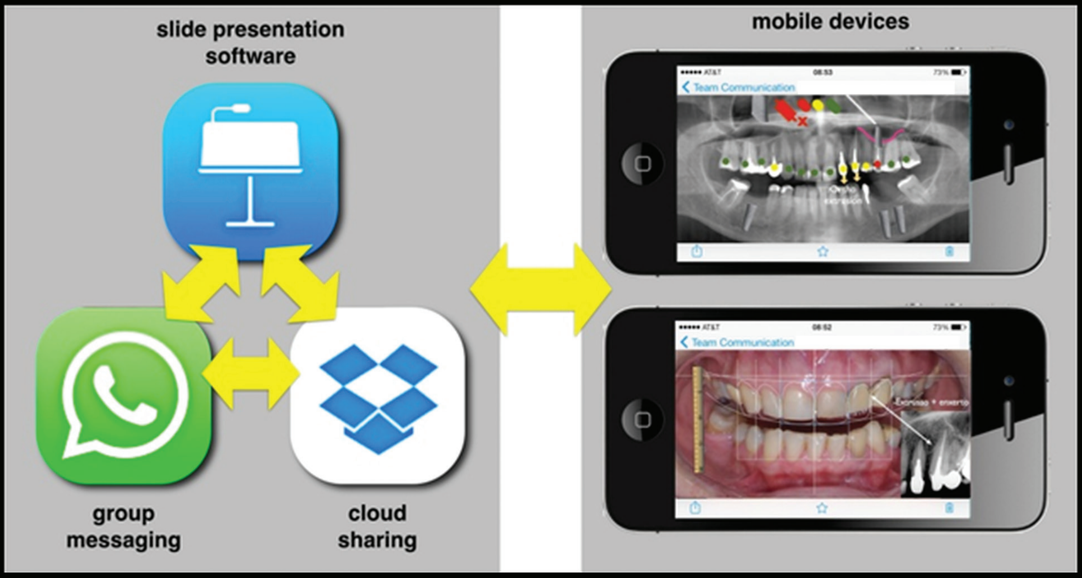


Figure 4: Online asynchronous communication.

Digital Wax-Up: The 2D to 3D Digital Link

The 2D smile frame can be translated into a 3D project, either analog (conventional wax-up) or digital (3D digital wax-up). The facial reference must also guide the digital 3D design. Therefore, the 2D smile frame project should be linked to 3D software programs. Using 2D/3D DSD Connect (Hack Dentistry; Bucharest, Romania), it is possible to overlap and calibrate 2D images over various 3D software programs **(Figs 5a-6c)**. Using software that already has the 2D/3D concept embedded is also an option to develop the 3D smile design project following the facially generated 2D smile frame (NemoDSD 2D/3D, Nemotec; Madrid, Spain) **(Fig 7)**.

Regardless of the type of 2D and 3D software employed, the final 3D file (in StereoLithography [STL] format) will be exported to a printing machine to generate the physical model of the new design. This model can be used to fabricate a matrix for a mock-up, the provisional, and also guides for tooth preparation, crown lengthening, and implant placement **(Fig 8)**.

Digital Performance in Interdisciplinary Dentistry

Orthodontics

The DSD Connect software also can be overlapped with orthodontic software programs such as Invisalign (Align Technology; San Jose, CA) and OrthoAnalyzer (3Shape; Copenhagen, Denmark) to guide the orthodontic digital setup **(Figs 9a-10b)**. The smile frame also can be integrated with orthodontic digital planning by using software that already has the 2D/3D link embedded (NemoDSD Ortho) **(Fig 11)**.

Implant Dentistry

The smile frame can be overlapped to cone beam computed tomography (CBCT) files and guided surgery software programs. It is possible to superimpose the smile frame over a CBCT file using the DSD Connect software **(Fig 12)**, or it can be automatically integrated with implant software programs that have the smile frame feature (NemoDSD Guided Surgery) **(Fig 13)**. The guided surgery software integrated with the smile design software enables the implant planning related to the facially guided 3D design (digital wax-up).

Periodontics

The crown-lengthening procedure also can be digitally planned **(Fig 14)**. The 3D design guided by the smile frame is printed and then a vacuum tray is fabricated showing the exact new position of bone and soft tissue **(Fig 15)**.

Orthognathic

In cases where restorative dentistry will be integrated with orthognathic surgery it is very important to integrate the smile frame and the 3D digital design of the restorations into the orthognathic software **(Fig 16)**.

CAD/CAM Restorations and Function

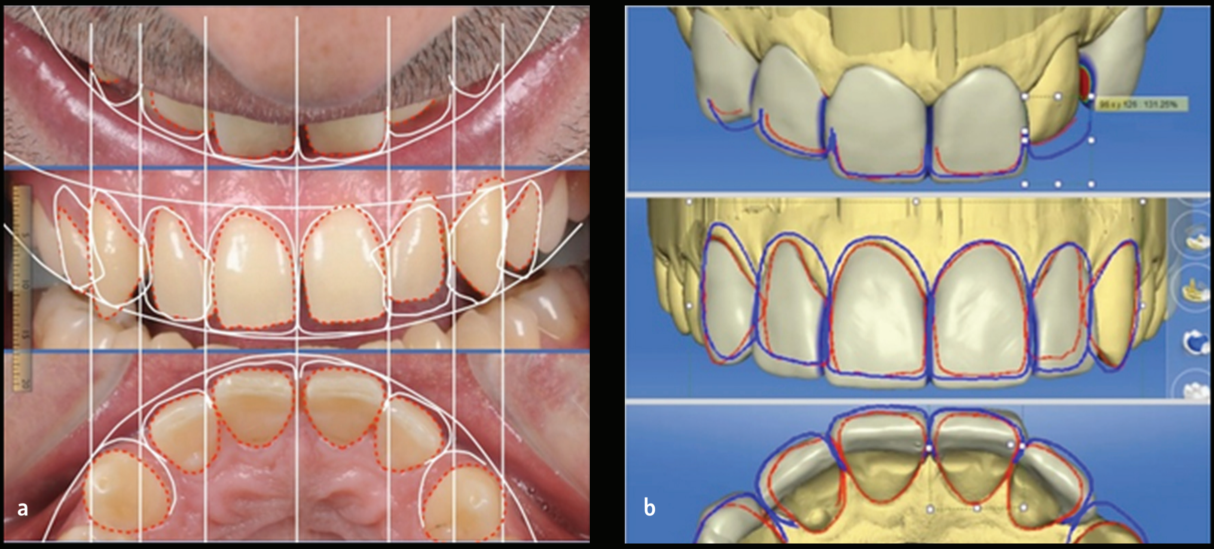
The upper facially guided smile design can be placed in the digital articulator to check the relationship between the new design and the actual occlusal situation. The goal is to adjust the esthetics to achieve ideal function. Most CAD/CAM software offers a virtual articulator that works as a semi-adjustable articulator, allowing for the adjustment of maximum intercuspal contacts, protrusion, and lateral movements **(Fig 17)**. When tooth preparation is done the STL file of the preparations can be overlapped onto the 3D design so the restorations can be designed following the exact same shape, position, arrangement, and occlusion that was developed on the 3D digital design **(Figs 18a & 18b)**.

Final Considerations

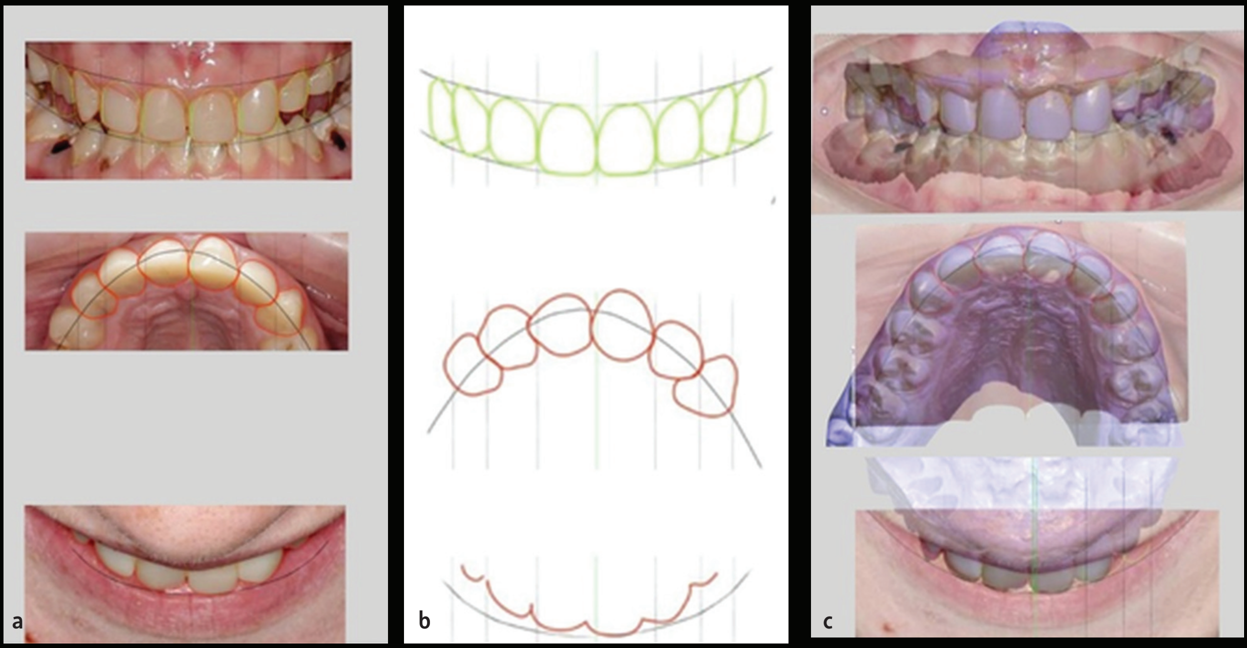
All the devices fabricated to perform the treatment—guides, splints, appliances, components, and restorations—should facilitate the process of maintaining precision between the initial plan and the final outcome **(Fig 19)**. The presentation to the patient begins with placement of the motivational mock-up, followed by the photography/video session. After the patient receives the motivational mock-up **(Fig 20)**, the treatment plan is presented. If the patient approves the plan, the rehabilitative procedures may be performed in a completely digital flow integrating the initial smile design project into the clinical orthodontic, periodontal, orthognathic surgery, guided implant surgery, and/or restorative procedures.

The case history, clinical examination, respect for biological principles, and knowledge of esthetic and functional references remain the keys to the success of the digital workflow, just as they always have been for the conventional workflow.

> **"Regardless of the type of 2D and 3D software employed, the final 3D file…will be exported to a printing machine to generate the physical model of the new design."**



Figures 5a & 5b: a) Smile frame developed on 2D software. b) Smile frame overlapped and calibrated to the 3D CAD/CAM software (Cerec, Sirona Dental Systems GmbH; Bensheim, Germany) guiding the shopping and arrangement of the 3D design.



Figures 6a-6c: a) Smile frame. b) Smile frame without the images. c) Smile frame overlapped and calibrated to the 3D CAD/CAM software (3Shape, Copenhagen, Denmark).

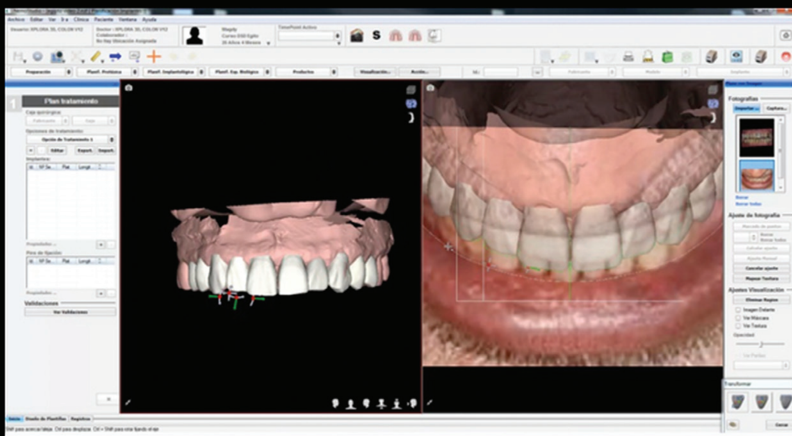
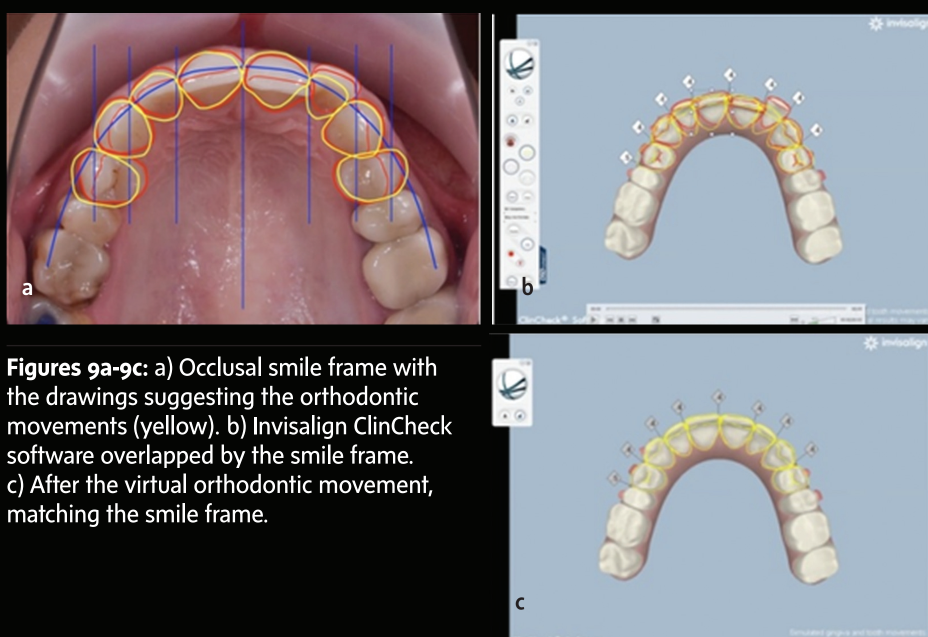
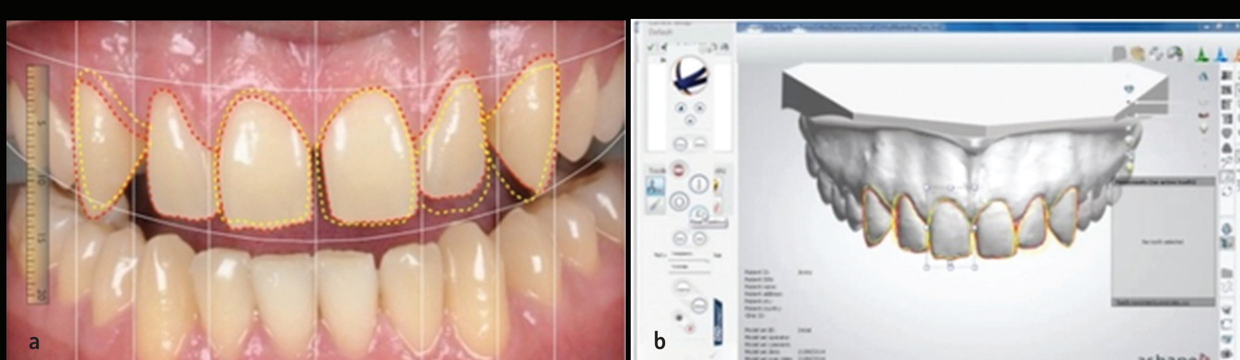


Figure 7: 3D smile design.

Figure 8: Printed models and vacuum tray.



Figures 9a-9c: a) Occlusal smile frame with the drawings suggesting the orthodontic movements (yellow). b) Invisalign ClinCheck software overlapped by the smile frame. c) After the virtual orthodontic movement, matching the smile frame.



Figures 10a & 10b: a) Frontal smile frame suggesting orthodontic movements (yellow). b) 3D model calibrated to the smile frame ready to start the virtual setup procedure.

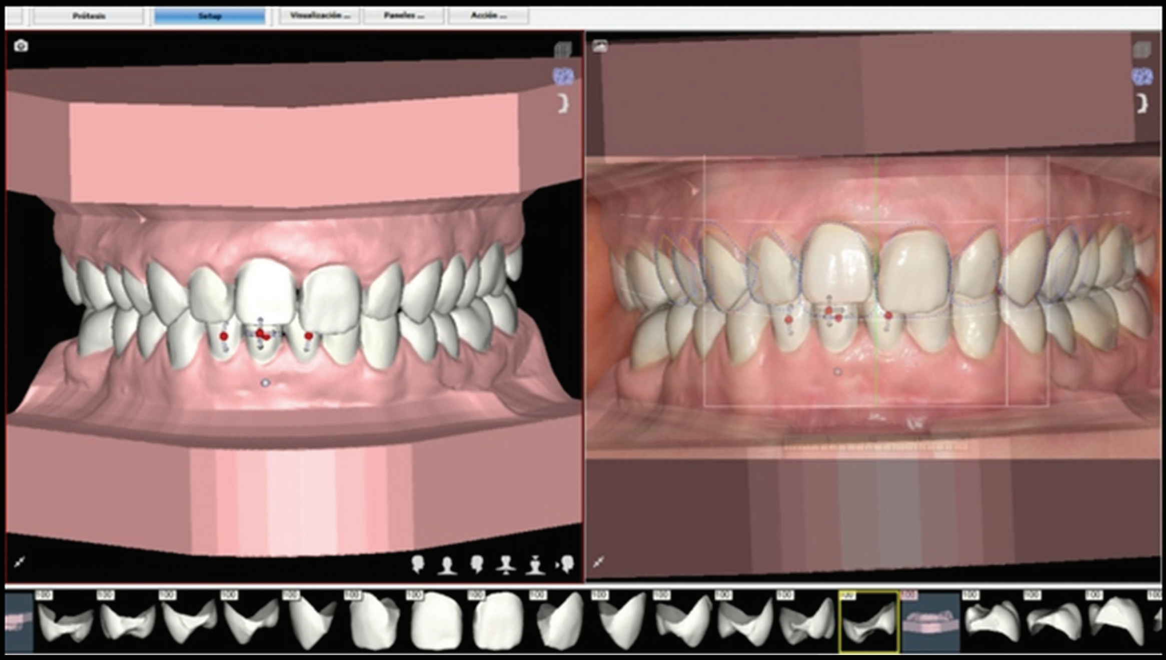


Figure 11: Digital Ortho software with the smile frame integrated.

Figure 12: CBCT file and smile frame superimposition using the Connect software program.

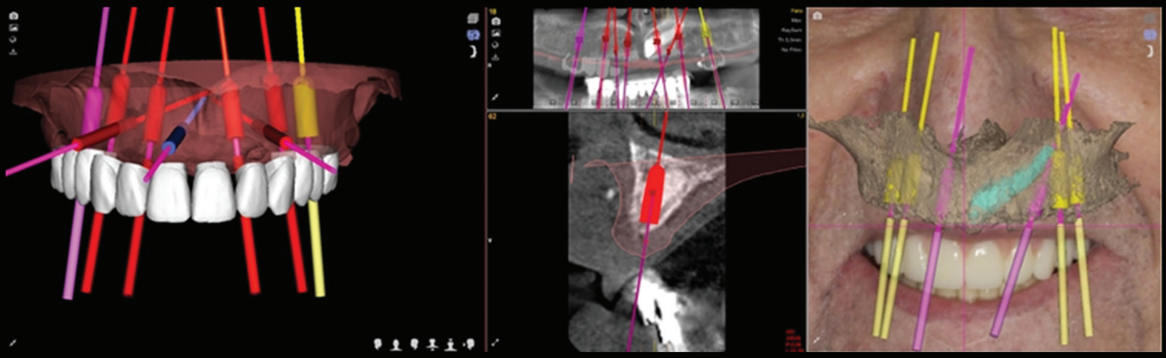


Figure 13: Smile frame, 3D scan model, and CBCT superimposed.

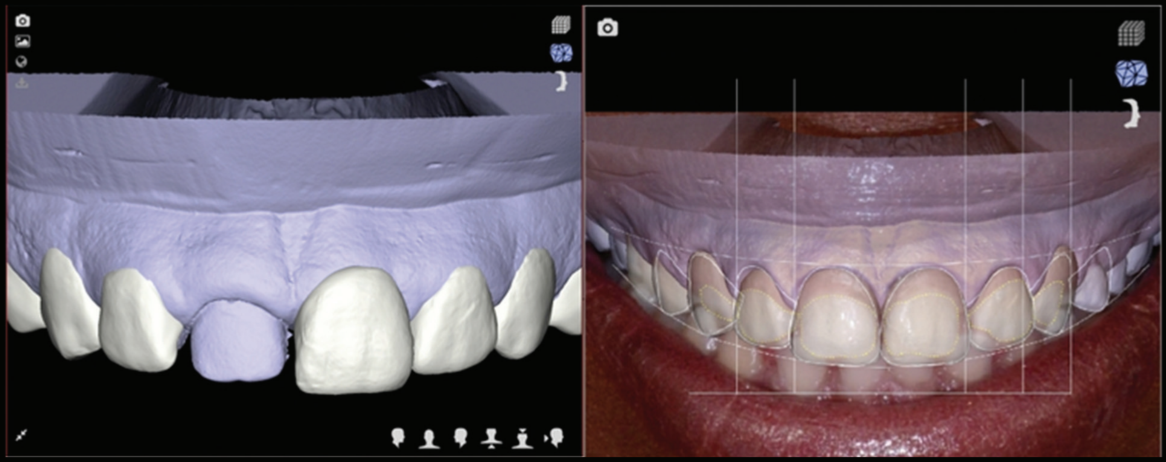


Figure 14: Overlapping the 2D smile frame of the 3D model to plan the crown-lengthening procedure.

Figure 15: The crown-lengthening guide designed to control the bone and soft tissue reduction based on the 3D digital design.

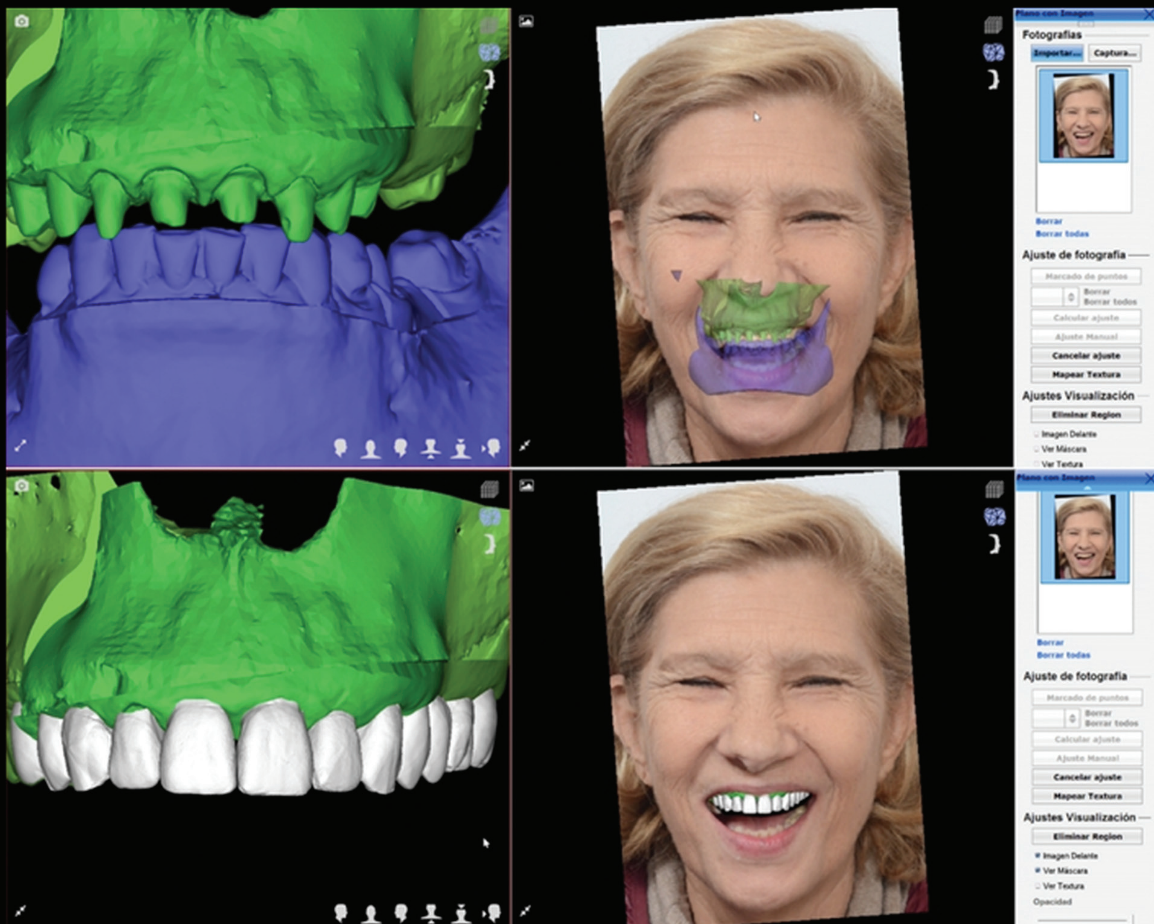


Figure 16: The Orthognathic NemoCeph software integrated to the smile design software.

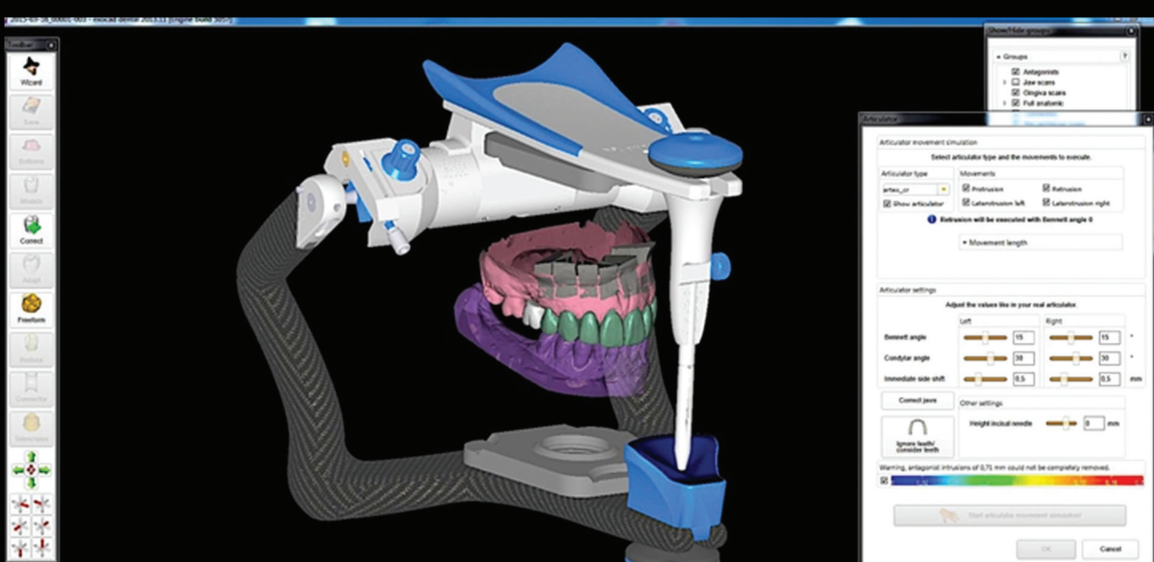
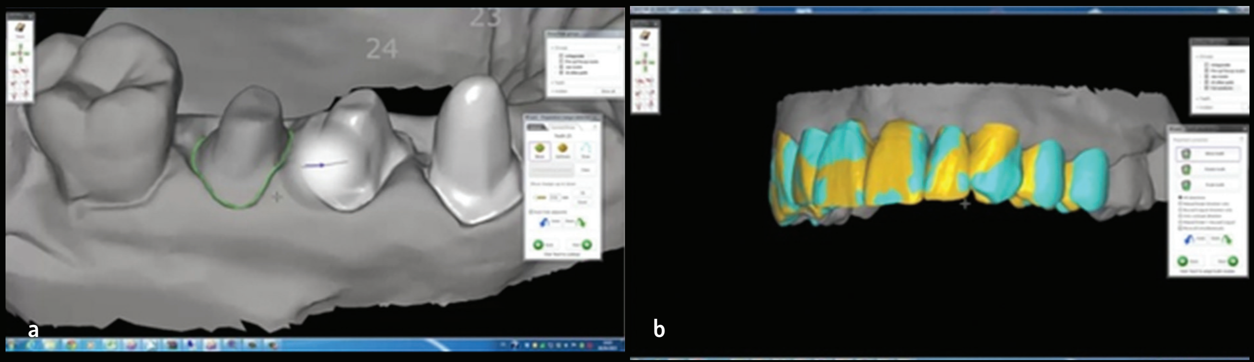


Figure 17: Facially guided smile design checked in the digital articulator.



Figures 18a & 18b: a) STL of the prepped model. b) The 3D restorations (yellow) are adapted to the digital wax-up (green).

Figure 19: All the devices and models digitally designed and fabricated with milling and printing technology.

Figure 20: Patient without and with the mock-up for the motivational presentation.

"All the devices fabricated to perform the treatment...should facilitate the process of maintaining precision between the initial plan and the final outcome."

References

1. Hämmerle CH, Cordaro L, van Assche N, Benic GI, Bornstein M, Gamper F, Gotfredsen K, Harris D, Hürzeler M, Jacobs R, Kapos T, Kohal RJ, Patzelt SB, Sailer I, Tahmaseb A, Vercruyssen M, Wismeijer D. Digital technologies to support planning, treatment, and fabrication processes and outcome assessments in implant dentistry. Summary and consensus statements. The 4th EAO consensus conference 2015. Clin Oral Implants Res. 2015 Sep;26 Suppl 11:97-101.

2. Joda T, Brägger U. Digital vs. conventional implant prosthetic workflows: a cost/time analysis. Clin Oral Implants Res. 2015 Dec;26(12):1430-5.

3. Wismeijer D, Mans R, van Genuchten M, Reijers HA. Patients' preferences when comparing analogue implant impressions using a polyether impression material versus digital impressions (Intraoral Scan) of dental implants. Clin Oral Implants Res. 2014 Oct;25(10):1113–8.

4. Joda T, Brägger U. Patient-centered outcomes comparing digital and conventional implant impression procedures: a randomized crossover trial. Clin Oral Implants Res. 2015 Apr 12. doi: 10.1111/clr.12600. [Epub ahead of print].

5. Lanis A, Padial-Molina M, Gamil R, Alvarez del Canto O. Computer-guided implant surgery and immediate loading with a modifiable radiographic template in a patient with partial edentulism: a clinical report. J Prosthet Dent. 2015 Sep;114(3):328-34.

6. Lewis RC, Harris BT, Sarno R, Morton D, Llop DR, Lin WS. Maxillary and mandibular immediately loaded implant-supported interim complete fixed dental prostheses on immediately placed implants with a digital approach: a clinical report. J Prosthet Dent. 2015 Sep;114(3):315-22.

7. Coachman C, Calamita MA. Digital Smile Design: a tool for treatment planning and communication in esthetic dentistry. Quintessence of dental technology (QDT) 2012. Hanover Park (IL): Quintessence Pub.; 2012. p. 103-11.

8. Lee SJ, Betensky RA, Gianneschi GE, Gallucci GO. Accuracy of digital versus conventional implant impressions. Clin Oral Implants Res. 2015 Jun;26(6):715-9.

9. Solaberrieta E, Minguez R, Etxaniz O, Barrenetxea L. Improving the digital workflow: direct transfer from patient to virtual articulator. Int J Comput Dent. 2013;16(4):285-92.

10. Lee SJ, Gallucci GO. Digital vs. conventional implant impressions: efficiency outcomes. Clin Oral Implants Res. 2013 Jan;24(1):111–5.

11. Reich S, Kern T, Ritter L. Options in virtual 3D, optical-impression-based planning of dental implants. Int J Comput Dent. 2014;17(2):101-13.

12. Mandelaris GA, Vlk SD. Guided implant surgery with placement of a presurgical CAD/CAM patient-specific abutment and provisional in the esthetic zone. Compend Contin Educ Dent. 2014 Jul-Aug;35(7):494-504.

13. Gallucci GO, Finelle G, Papadimitriou DE, Lee SJ. Innovative approach to computer-guided surgery and fixed provisionalization assisted by screw-retained transitional implants. Int J Oral Maxillofac Implants. 2015 Mar-Apr;30(2):403-10.

14. Ganz SD. Three-dimensional imaging and guided surgery for dental implants. Dent Clin North Am. 2015 Apr;59(2):265-90.

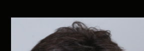
15. Kapos T, Evans C. CAD/CAM technology for implant abutments, crowns, and superstructures. Int J Oral Maxillofac Implants. 2014;29 Suppl:117-36.

16. Keerthi S, Proussaefs P, Lozada J. Clinical and laboratory steps for fabricating a complete-arch fixed prosthesis using CAD/CAM. Int J Periodontics Restorative Dent. 2015 Jul-Aug;35(4):473-80.

17. Gracis S, Thompson VP, Ferencz JL, Silva NR, Bonfante EA. A new classification system for all-ceramic and ceramic-like restorative materials. Int J Prosthodont. 2015 May-Jun;28(3):227-35. **jCD**

> **"The case history, clinical examination, respect for biological principles, and knowledge of esthetic and functional references remain the keys to the success of the digital workflow, just as they always have been for the conventional workflow."**

Dr. Coachman has a private practice in São Paulo, Brazil.



Dr. Calamita has a private practice in São Paulo, Brazil.

Dr. Sesma is an assistant professor, Department of Prosthodontics, School of Dentistry, University of São Paulo, São Paulo, Brazil.

Disclosures: Dr. Coachman is a co-founder of DSD.
Dr. Calamita is on the advisory board of DSD.
Dr. Sesma is on the advisory board of and is an instructor for DSD.

Advertiser

Page **75**

“Title”

Premium

New

Pick up