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DENTAL TECHNIQUE

Chairside 3D digital design and trial restoration workflow

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ABSTRACT

Different digital tools have been used in clinical practice to assist in the planning and rehabilitation of patients. Some applications (apps) and software programs used in esthetic planning allow simulation of the smile design, improving communication between patients and professionals. Nonetheless, they are usually difficult to use, time-consuming, unattractive to present to the patient, and complicated to link with the 3D workflow. This article presents a new 3D digital smile design app for esthetic planning, smile simulation, chairside 3D virtual wax pattern, and trial restoration performed with portable devices. In this technique description, a facial frontal photograph, a facial scan standard tessellation language (STL) file, and a maxillary intraoral scan STL file were uploaded to the app. The files were calibrated to each other to allow a 3D facially driven smile design project. The definitive maxillary 3D digital waxing of facial templates was exported to a 3D printer as an STL file. The printed resin templates were directly placed in the mouth with flowable composite resin for an immediate trial restoration without the need for casts, silicone guides, or autopolymerizing resin. The workflow presented in this article linked the 3Dapp project to a printer and allowed straightforward chairside trial restorations. (J Prosthet Dent 2019;■:■-■)

Virtual smile design software and applications (apps) have been used to create a digital restorative design from which it is possible to visualize the definitive outcome and to present it to the patient before the restorative procedures begin.[1-8] Different systems have been available for designing the smile; however, a challenge of the available systems is to reproduce the 2D planning in 3D.[5,7,9] Despite the currently available digital technology for 3D virtual planning,[10-12] the integration between 3D data acquired from scanning systems and 2D images is usually limited to a single view mode, which may limit the accuracy of the smile design technique.[7]

A further limitation is the time required to reproduce the digital planning on a trial restoration suitable for clinical use. The complete digital workflow is usually restricted because current software programs do not support chairside acquisition of the planned trial restoration.[7] The 3D smile design project can be exported as a complete cast standard tessellation language (STL) file or as a template STL file[13,14] to a computer-aided design (CAD) software program, a milling machine, or a printer. In most situations, this workflow is only possible by having the virtual cast printed at a center, which can be a time-consuming and expensive procedure (Table 1) and demands a complex laboratory CAD software program with an extended learning curve.[15,16] Conversely, chairside printing of resin matrices makes the treatment more straightforward and faster because the digital planning and the clinical evaluation can be performed during the same appointment (Fig. 1).

Integration of the 2D and 3D data and chairside acquisition of the 3D printed resin templates are possible by means of a 3D digital smile design app (DSDApp 3D) for chairside esthetic planning, smile simulation, 3D virtual waxing, and printed trial restorations made with a portable device.

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Table 1. Comparison between outsourced 2-appointment workflows and chairside 1-appointment workflow

Outsourced 2-Appointment Workflow		Chairside One-Appointment Workflow	
	Estimated Time*		Estimated Time*
Five facial photographs/no video+impression+cast scanning in the laboratory	20	Facial scan+1 photograph+1 facial video with smile dynamics+IOS	10
Two-dimensional smile simulation in keynote/ power point	25	Automated 2D smile simulation in app supported by AI technology	5
Export 2D files to a 3D CAD laboratory software program	5	Two-dimensional/3D files automatically integrated in app	
Three-dimensional smile design in a CAD laboratory software program	20	Intuitive chair-side 3D smile design	35
Three-dimensionally printed cast in laboratory	20	Three-dimensionally printed resin templates in office	20
Silicone index+bisacryl resin trial restoration (setting, removing excess, adjustments)	15	Shells trial restoration templates	0.5
Total	105	Total	70.5

*In minutes.

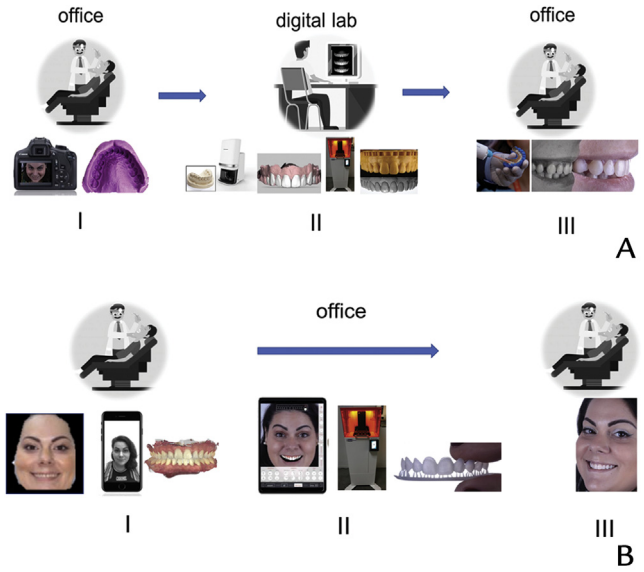

Figure 1. A, Outsourced workflow: I) photographs and impression; II) cast scanning, 2D smile simulation in presentation software, 3D smile design in CAD software, 3D printed cast; III) silicone index, autopolymerizing resin trial restoration. B, Chairside workflow: I) facial scan, video recording of smile dynamics, intraoral maxillary scanning; II) 2D or 3D smile design in same app with automatic link, 3D printed templates; III) snap-on resin template trial restoration. CAD, computer-aided design.

TECHNIQUE

1. Start with the patient digitalization. A frontal facial smiling photograph and a facial scan are all that is needed for a facially driven digital smile design. Reference lines and vertical and horizontal angles presented on the app will help capture the photograph with the best angulation and positioning. Facial scan files made with another device can be added or can be captured directly on the DSDApp using the integration with a 3D face app (Bellus 3D).

2. Scan the maxillary arch by using an intraoral scanner (IOS) to obtain an STL file. The app accepts files from any IOS. After importing the STL file and saving the patient's documentation, choose DSD Cloud to securely store the files. These can be opened and visualized on the DSDApp iPad version (Apple) to continue with the smile design (Fig. 2).

3. After patient digitalization, adjust the position of the maxillary cast file and determine the pivot on the virtual cast, which represents the axis around which the 3D cast will rotate (Fig. 3). The automatic facial flow of the DSDApp will help determine any facial asymmetries for an improved smile design (Fig. 4A, 4B). Then, superimpose the virtual cast and the facial STL file on the photograph based on the size and position of the anterior teeth (Fig. 4C). Calibrate the occlusal view by determining the new occlusal curve (Fig. 4D).

4. Create the facially guided 2D smile frame by using reference lines. Determine the length of the central incisors and the incisal curve following the lower lip in the dynamic analysis of the facial video (Fig. 5A).[3,5,6,17-19] Then, the app simulates an initial proposal of a 2D smile. A library containing different shapes of teeth with natural morphology and texture is used to create the desired result (Fig. 5B, 5C). Mark the lower border of the upper lip to simulate the design under the lips effect (Fig. 5D). Use the software's before and after comparison tool to virtually show the patient the expected result and communicate the treatment wishes and expectations (Fig. 5E).

5. Perform the 3D digital wax pattern starting on the 4 views screening to adjust the position of the teeth for a motivational trial restoration design (Fig. 6A, 6B). Superimpose the facial and IOS STL to evaluate the harmony of the 3D virtual wax pattern with the face (Fig. 6C). Use the Sculpt tool to add, remove, or modify the tooth mesh according to the smile frame (Fig. 6D) following the harmony of the facial scan file. Export the template STL file to a chairside 3D printer (Fig. 6E).

6. Manufacture the resin templates with a stereolithography process (remove the 3D printing support,

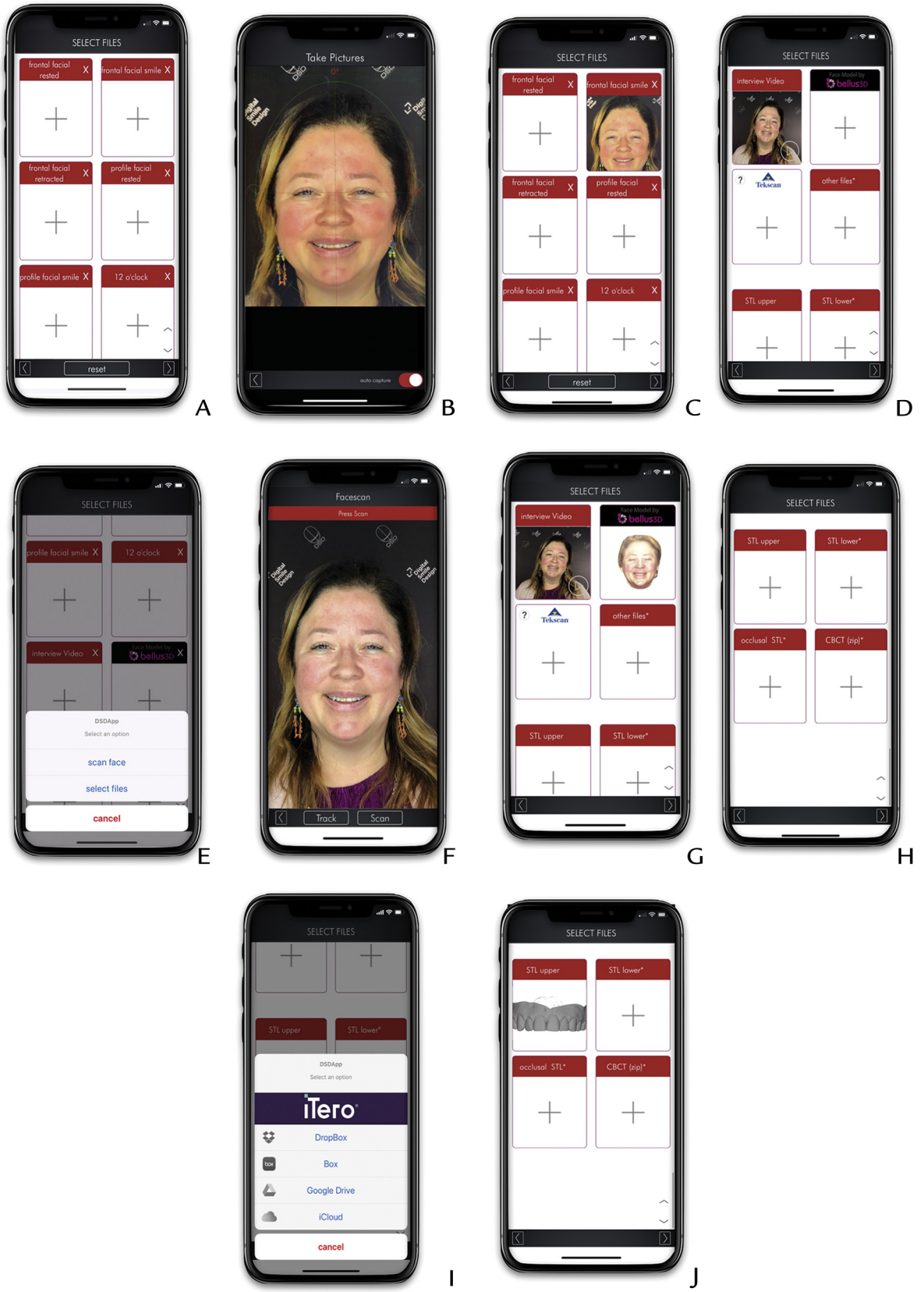

Figure 2. A, Patient files can be saved on app. B, Autocapture and reference lines for best positioning. C, Photograph made and incorporated into documentation. D, Video made with app. E, F, Scanning face process inside of app. G, Facial scan added to documentation. H, I, Adding maxillary STL file directly from scanner. J, IO STL scan added to documentation. STL, standard tessellation language.

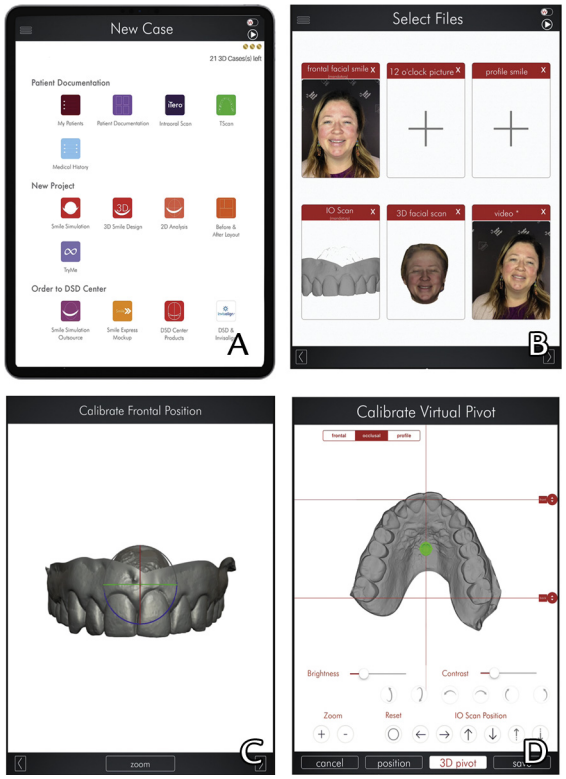

Figure 3. Calibration (screen shot). A, Menu screen to start new project. B, Patient documentation open. C, STL position calibration. D, STL virtual pivot positioning. STL, standard tessellation language.

Figure 4. A, Facial reference lines (interpupillary, commissure lines, and facial midline) enables rotation and adjustment of photograph. B, Facial flow analysis automated in app. C, Superimposition of facial STL, D. Determine new occlusal curve. STL, standard tessellation language.

wash, and polymerize) (Fig. 7A). Insert the resin templates with drops of flowable composite resin and light-polymerize to create a snap-on trial restoration. Record and make pictures of the patient with the trial restoration and create a presentation on the DSDApp adding photographs, videos, and files from the smile simulation and 3D design to show and motivate the patient (Fig. 7B-D).

DISCUSSION

Currently, one of the biggest challenges with digital dentistry is to store and organize files from different files formats. The present article describes how to gather all digital information from different devices by using only one mobile app. With patient digitalization and cloud dentistry, all the discussions, solutions, and decisions can be performed online, in an asynchronous way, allowing the team to communicate at anytime and anywhere.

According to the reported technique, the complete patient documentation and design files can be easily opened on a cell phone and shared with the professional team involved in the interdisciplinary facially driven treatment planning. Additionally, files can be exported to other devices without the need for an additional software program, making the DSDApp a reliable and low-cost solution for dental offices.

Adding to the improved patient digitalization process, DSDApp 3D can be used in 2 different stages of treatment. The first stage is before treatment acceptance. The app is used to simulate a smile and make a trial restoration, communicate with the patient, create a link, and motivate the patient to understand the benefits of a better smile. At the second stage, during the restorative treatment, the app is used for a new 2D simulation and 3D technical trial restoration following the initial design plan, such as to adjust the shape and contour of definitive restorations, reducing the time for adjustments in the clinical evaluation appointment. It brings high predictability from initial planning until delivery of restorations. The similarity between digital

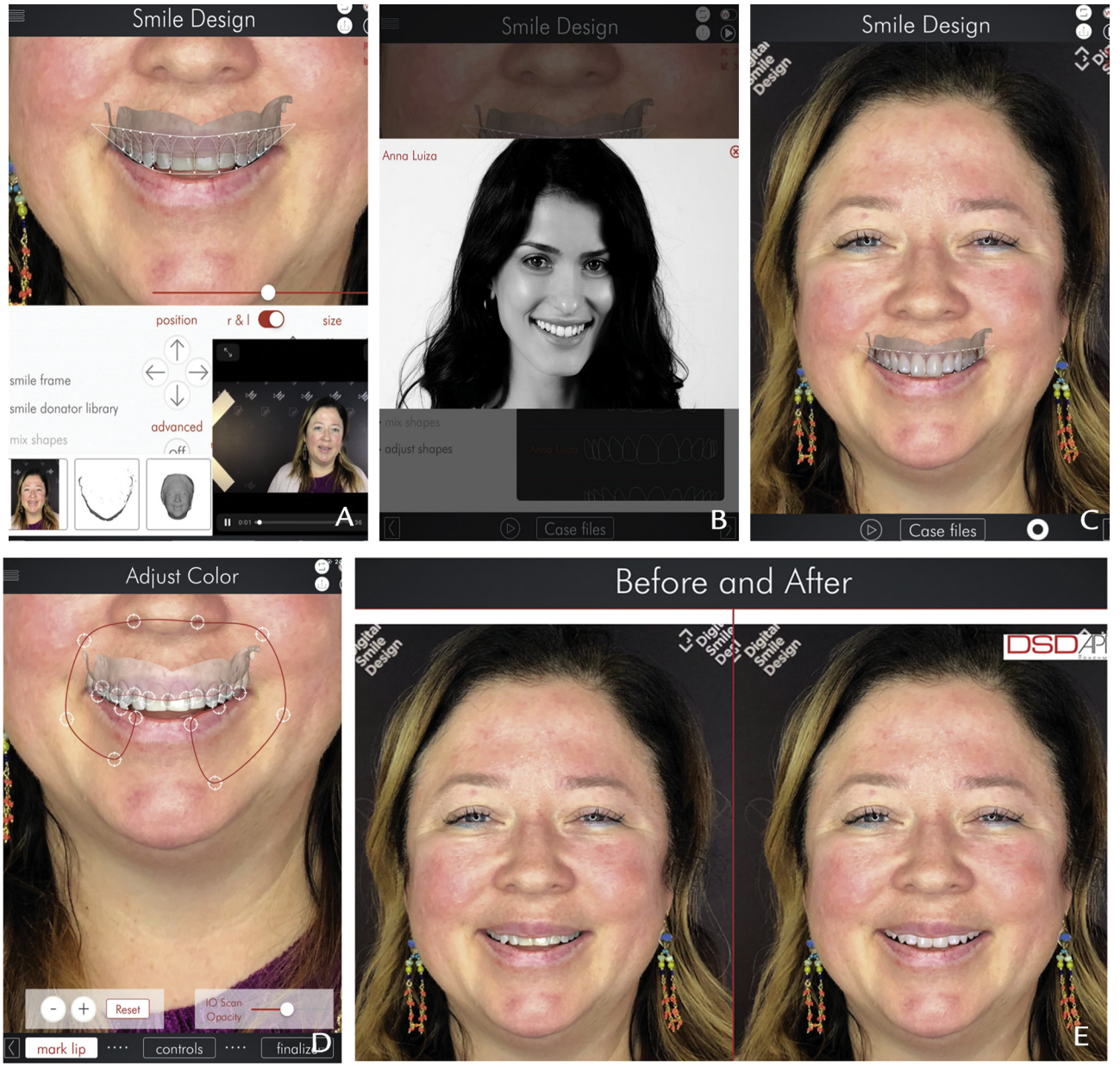

Figure 5. Two-dimensional smile simulation (screen shot). A, Facially guided smile frame in dynamic analysis visualizing treatment files and videos. B, Desired result based on smile donator template. C, Facial verification of proposed design. D, Marking upper lip. E, Before and after smile simulation in 2D.

and trial restoration files and the definitive restorations shows the predictability that can be achieved through the concept termed "Copy/Paste Dentistry". The files generated in the app can be opened by using any CAD software program to continue the restorative process with predictability.

A further advantage provided by the app is to use video recording during the 3D virtual wax pattern to guide the smile design process. By using this tool, the accuracy of treatment planning can be increased by capturing the dynamic smile. Considering that the patient's smile may not be spontaneous in photographs, the dynamic smile captured in video recording is more realistic and may be helpful in defining the patient's actual needs, especially for complex rehabilitations.[3] With the high quality of today's cell phones, it provides a great tool for making the video, frontal photograph, and facial scan, all with one device. A cell phone with the facial recognition feature allows the facial scan to be made

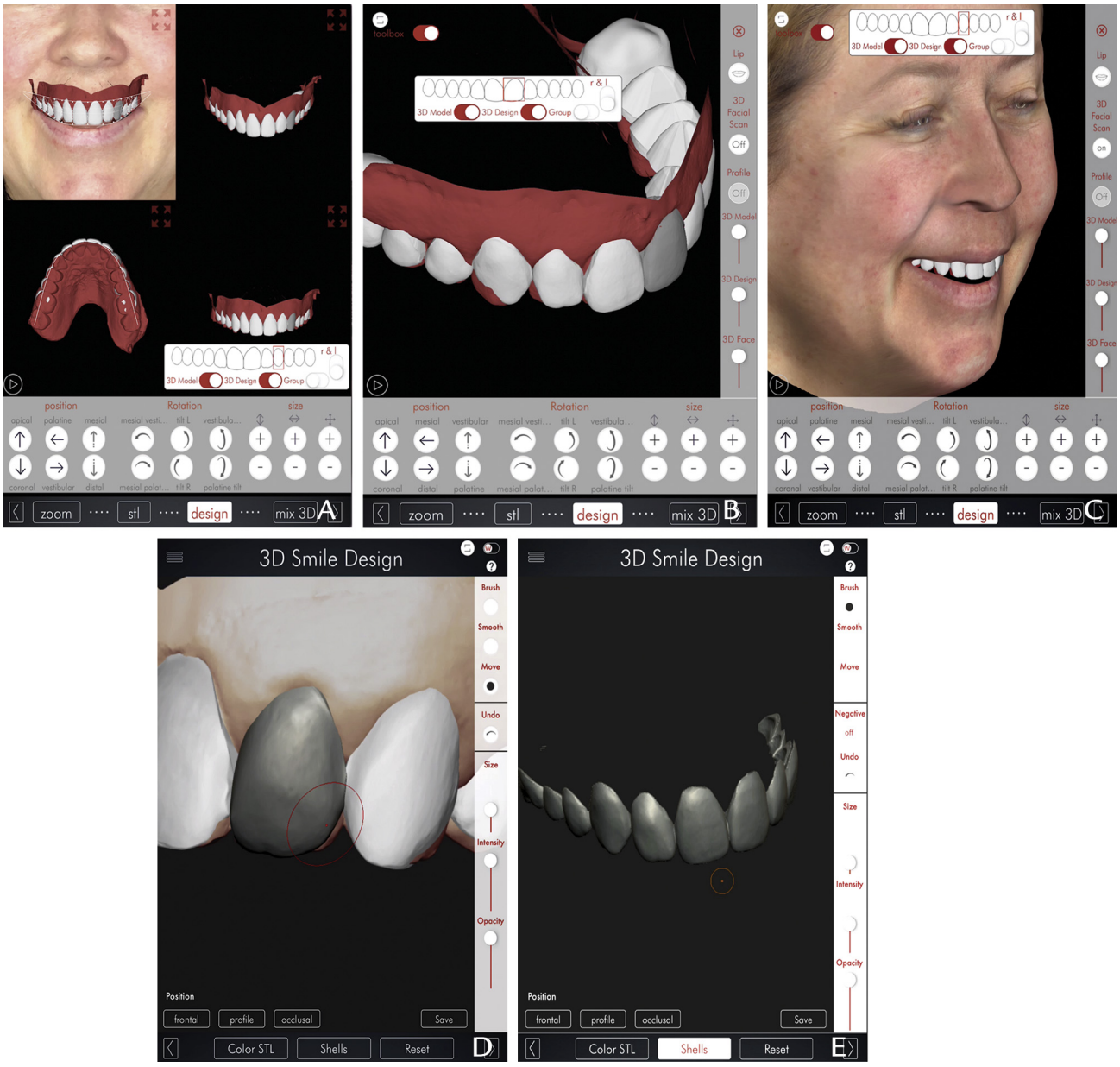

Figure 6. Three-dimensional smile design (screen shot). A, Four views in 3D. B, Dynamic view for detailed 3D design. C, Superimposition of facial STL and maxillary STL file with 3D smile design. D, Digital wax pattern using Sculpt tool (tooth structure added, removed, and changed according to smile frame). E, Shell STL file exported to chairside 3D printer. STL, standard tessellation language.

and excludes the need for different photograph angles as it can be rotated for evaluation during 3D smile design.

Intraoral scans generate 3D images with excellent color, removing the need for intraoral photography for treatment planning. Therefore, as demonstrated in this article, a full facially driven smile can be designed with 4 files: a frontal smiling photograph, a video, a facial scan, and an IO scan. Moreover, the resin templates can be printed chairside to fabricate a trial restoration. This approach allows the virtual treatment plan and the clinical evaluation to be performed in the same appointment (Table 1).

The limitations include that the trial restorations are not appropriated for patients with extensive horizontal or vertical overlap because trial restorations require an additive approach. Additionally, integration of the mandibular arch STL file to evaluate occlusion is not available with the present version, restricting the use of the app for planning occlusal rehabilitations.

Figure 7. A, Clinical evaluation with trial restoration showing 3D printed facial templates. B, Presentation files and photographs and videos of trial restoration added to app to create presentation. C, D, Presentation.

SUMMARY

The new DSDApp 3D is a straightforward and versatile tool for performing digital planning in dental practice. As it does not require any complex software program, the clinician can easily use it by means of a mobile device, reducing costs, minimizing the learning curve, and saving time. For clinicians who wish to augment the smile analysis, the app can also be used in combination with other digital technologies. In addition, esthetic planning can be optimized by scanning the face and the mouth, making a facial video with smile dynamics, designing the 3D smile in the app, printing the resin templates, and performing the clinical trial in the same appointment.

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