DENTAL TECHNIQUE

Guided-welded approach planning using a computer-aided designed prosthetic shell for immediately loaded complete-arch rehabilitations supported by conometric abutments

Alberto Maria Albiero, MD,[a] Renato Benato, MD, DMD,[b] Stefano Momic,[c] and Marco Degidi, MD, DDS[d]

Prosthetically driven planning is necessary to achieve optimal implant positioning and an ideal prosthetic rehabilitation.[1,2] A dental implant planning software program using cone beam computed tomography (CBCT) has facilitated the 3D planning of dental implant placement according to a restoratively driven treatment plan.[3,4] The introduction of these digital technologies to implant dentistry has improved the predictability of clinical and laboratory procedures.[5] A computer-aided designed (CAD) diagnostic waxing or a digital scan of a diagnostic denture waxing could be used to plan the position of the implants. When immediate loading is planned, these data can be used to combine computer implant placement with an immediate loaded prefabricated prosthesis.[6]

Albiero et al[7-9] published a protocol for immediate loading of guided implants by using restorations supported by an intraoral welded titanium framework (guided-welded approach). The use of cone-in-cone abutments to retain fixed dental prostheses has been reported as an alternative to cemented or screw-retained restorations.[10-13] Cone-in-cone, conometric, abutments use friction retention to attach the coping to the abutment. Cement or screws are not needed, but a lack of parallelism between copings can interfere with

ABSTRACT

In guided surgery, implants can be planned from radiographic guide information according to a restoratively driven treatment plan. Unfortunately, the palatal or lingual surface of teeth cannot be easily identified. The present article describes the use of a digitally designed prosthetic shell to improve the accuracy of guided-welded approach planning for immediate restorations supported by conometric abutments. Importing the virtual shell into the planning software provides an effective protocol for using the definitive prosthetic space information to plan the framework shape and position predictably. This method increases the accuracy of virtual planning and reduces the time needed to reline the prosthetic shell. (J Prosthet Dent 2019;122:510-5)

retention. For this reason, abutments must be as parallel as possible.

Recently, Albiero et al[14] reported a workflow using the optical scan data of the conometric coping to improve the accuracy of computer-guided implant planning when a guided-welded approach is planned for immediate restorations supported by conical abutments. In completely edentulous arches, guided implants can be planned according to a restoratively driven treatment plan using radiographic guide information. Unfortunately, the palatal or lingual surface of teeth cannot be easily identified, and the emergence profile of the future restoration cannot be visualized in the planning software. If an immediately loaded fixed restoration is planned with a guided-welded approach, information about the definitive prosthetic shell shape is lacking and the thickness could be underestimated. Consequently, on the day of surgery, the framework could interfere with relining the prosthetic shell.
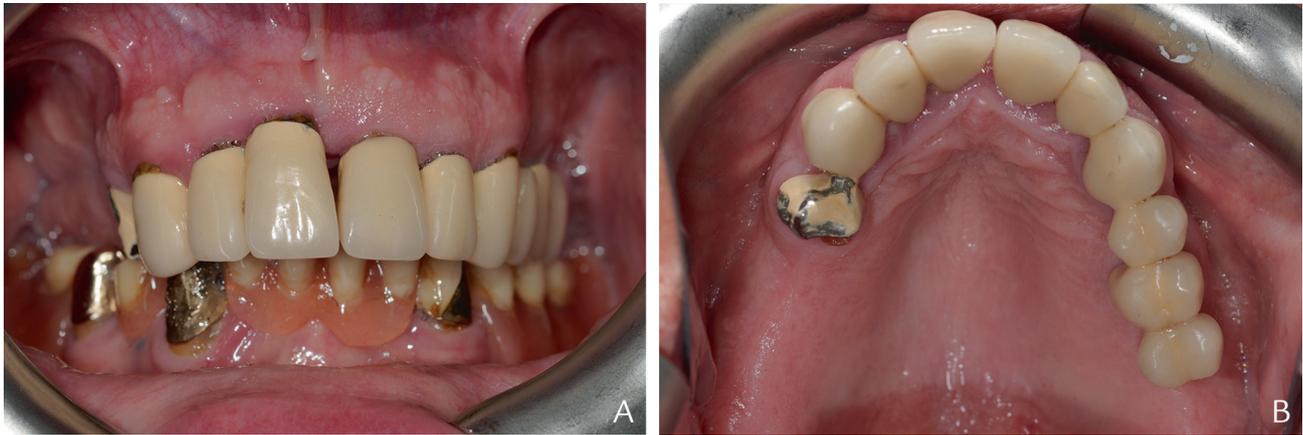
This article describes the workflow for designing and importing the prosthetic virtual shell into the

[a]Specialist in Maxillofacial Surgery, Private practice, Udine, Italy.
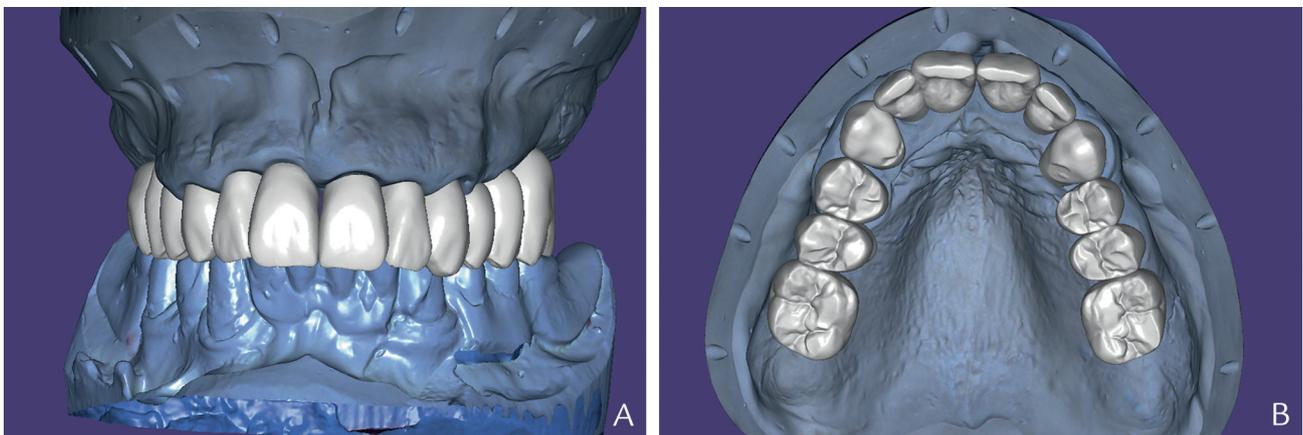[b]Private practice, Udine, Italy.
[c]Dental Technician, Private practice, Trieste, Italy.
[d]Private practice, Bologna, Italy.

**Figure 1.** Pretreatment views. A, Frontal view. B, Occlusal view.

Figure 2. Virtual prosthetic shell. A, Frontal view. B, Occlusal view.

planning software to use the definitive prosthetic space information to plan the framework shape and position predictably when an immediately loaded titanium-reinforced restoration supported by cone-in-cone abutments is planned with a guided-welded approach.

TECHNIQUE

1. Make impressions of the maxillary and the mandibular arches (Fig. 1). Fabricate diagnostic casts and mount them on a semiadjustable articulator.
2. Scan the diagnostic cast of the maxillary (Standard Tessellation Language [STL] 1) and mandibular arches (STL2) and diagnostic casts in the maximal intercuspal position using an optical scanner (Sinergia Scan; Nobil Metal) and import the STL files into the scanning software (Dentalscan 6.5; exocad)
3. Remove the teeth to be extracted from the maxillary cast to the gingival level, scan the cast (STL3), and import STL3 into the CAD software aligning it with STL1 to maintain information regarding the occlusal vertical dimension. Import STL2 and STL3 into another CAD software (Dental Designer; 3Shape) and design the virtual prosthetic shell (STL4) (Fig. 2).
4. Use this 3D information to mill a 2-piece radiographic guide as suggested by Cantoni and Polizzi[15] and reline it in the patient's mouth.
5. Use a dual-scan protocol (Dual Scan module for Simplant; Dentsply Sirona). Make the first CBCT scan of the patient wearing the base portion of the radiographic guide and the second CBCT scan of the 2 parts (the base and the tooth arrangement portions) of the radiographic guide assembled. Import and match the Digital Imaging and Communications in Medicine (DICOM) data sets into the Simplant software. Plan the implant placement (Ankylos; Dentsply Sirona). Then plan the nonindexed Ankylos SynCone abutment height and angulation according to the prosthetically driven treatment plan. Plan this step and evaluate the possible position of the titanium bar
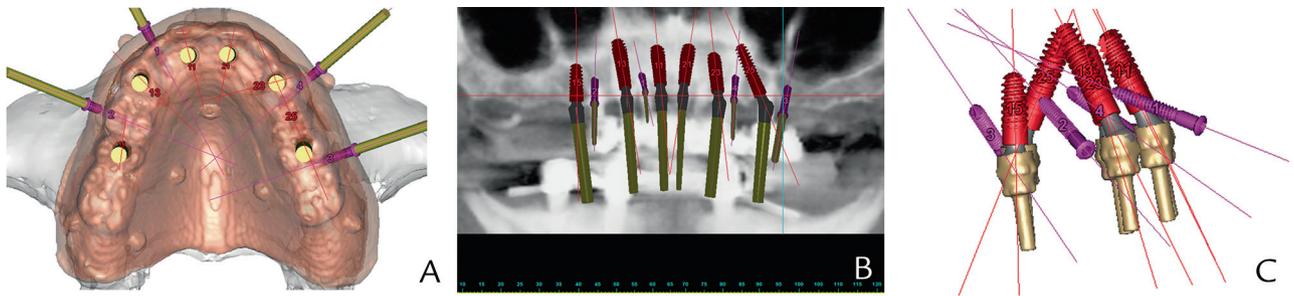
Figure 3. Virtual prosthetically driven planning. A, Radiographic guide (*orange* outline). B, Implant positions and abutment angulations selected to parallel restorative spaces. C, Conometric coping optical scan data imported into implant planning software.
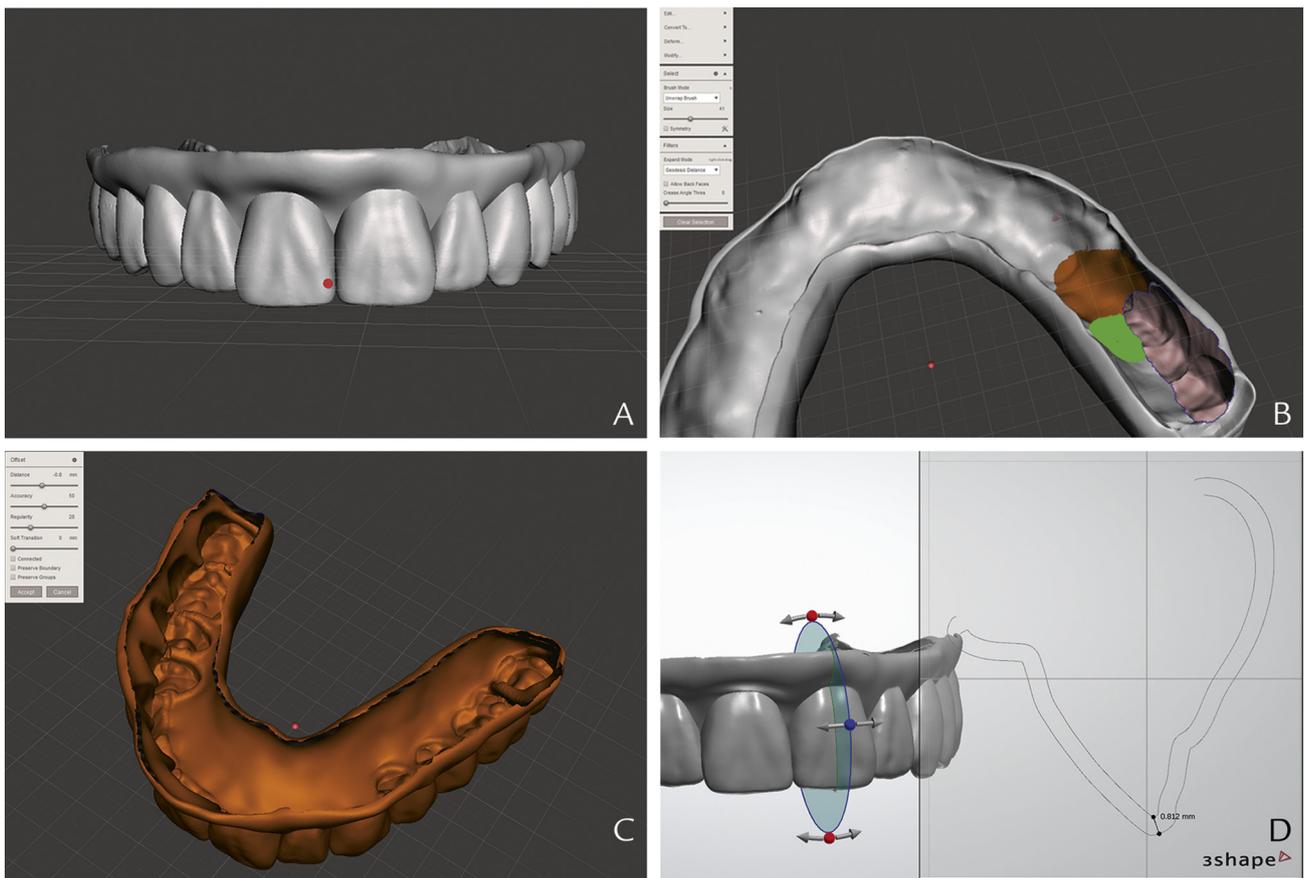

Figure 4. A, STL4 file imported into CAD software (Meshmixer; Autodesk). B, Thickness generated from intaglio surface of virtual waxing. C, Intaglio surface of edited shell. D, STL5 file imported into Dental Designer CAD software to show new shell thickness. CAD, computer-aided design; STL, standard tessellation language.

(Fig. 3A, B). Scan a conometric welding coping (Ankylos welding cap for SynCone; Dentsply Sirona) as described by Albiero et al[14] and import the STL file into the planning software, positioning 1 virtual cone-in-cone coping on each abutment (Fig. 3C).

6. Import the STL4 file into another CAD software (Meshmixer; Autodesk). Modify the virtual waxing by removing the base of the prosthetic teeth. Edit the file increasing the thickness from the intaglio surface to 0.8 mm (STL5) using the edit-offset tool (Fig. 4).

7. Import the STL4 and STL5 files into the planning software and match and align them with the radiographic guide by using the Optical Scan Wizard (Simplant; Dentsply Sirona). Select at least 3 tooth cusps in the 3D model of the radiographic guide. Then select the same tooth cusps in the 3D
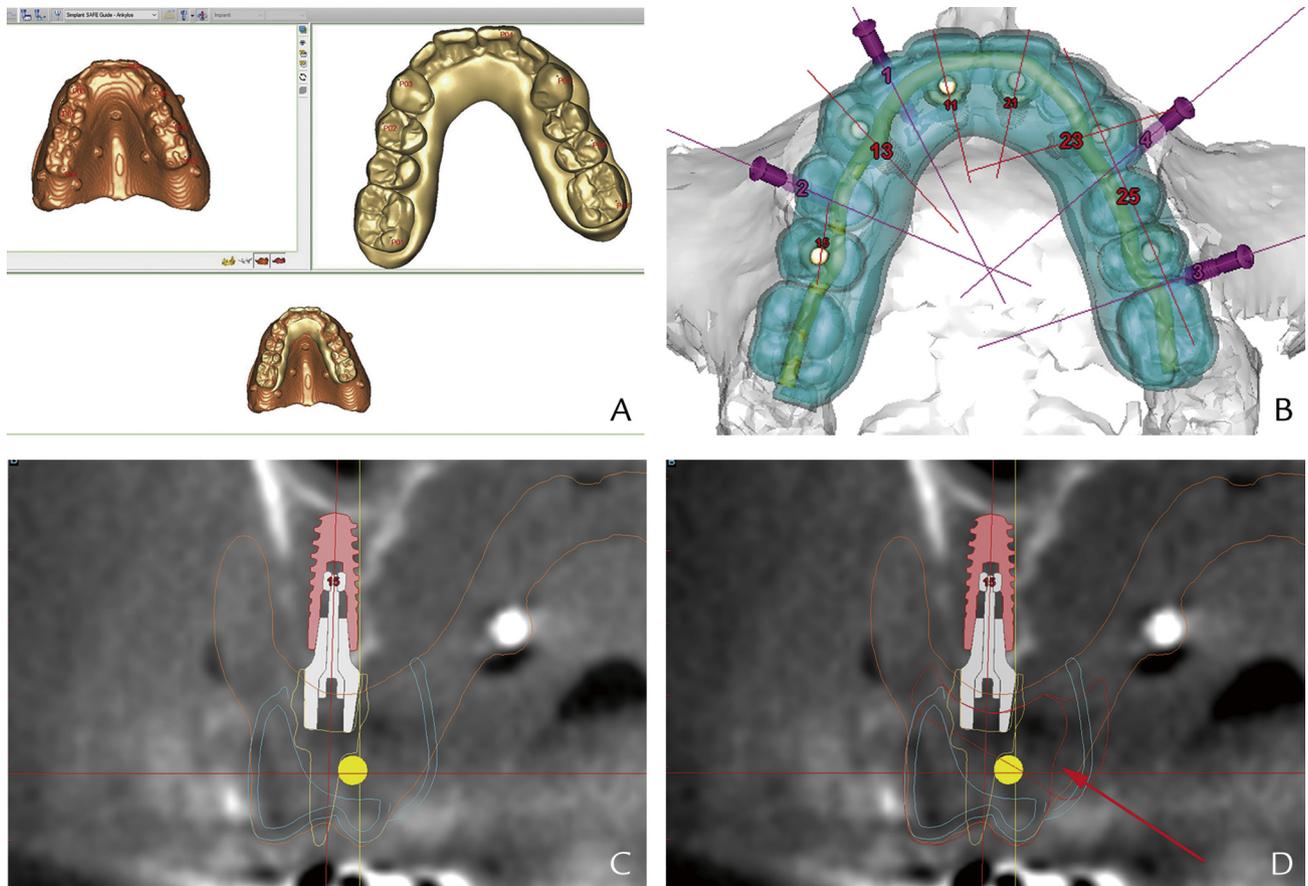
Figure 5. A, Virtual shell aligned with radiographic guide in planning software. B, Titanium bar designed into planning software considering STL5 information. C, Cross section with virtual shell (STL5) (*light blue* outline). Radiographic guide (*orange* outline). D, Cross section with STL4 information (*red* outline). *Red arrow* indicates palatal surface. STL, standard tessellation language.

Figure 6. A, Titanium bar preshaped on definitive cast. B, Optical scan data of definitive cast. C, Optical scan data of definitive cast imported into virtual planning.

model of the STL4 model. Confirm the match in the combined 3D view window (Fig. 5A). Repeat this step for STL5 matching. In the virtual environment, use the software's tool to draw the bar, considering the actual prosthetic space (Fig. 5B). Make sure the framework remains inside the virtual shell design (STL5) through the cross sections (Fig. 5C) and inside the future shape of definitive prosthetic teeth (STL4) (Fig. 5D).

8. Order the surgical guide (Simplant; Dentsply Sirona) by transferring the planning data. Use the surgical guide to position dental implant analogs into the definitive cast by using the positioning aids (Ankylos Positioning Aid; Dentsply Sirona). Screw the abutments into the dental implant analogs, rotating them as closely as possible to those planned in the software. Connect the cone-in-cone copings to the abutments. Preshape a 2.0-mm-
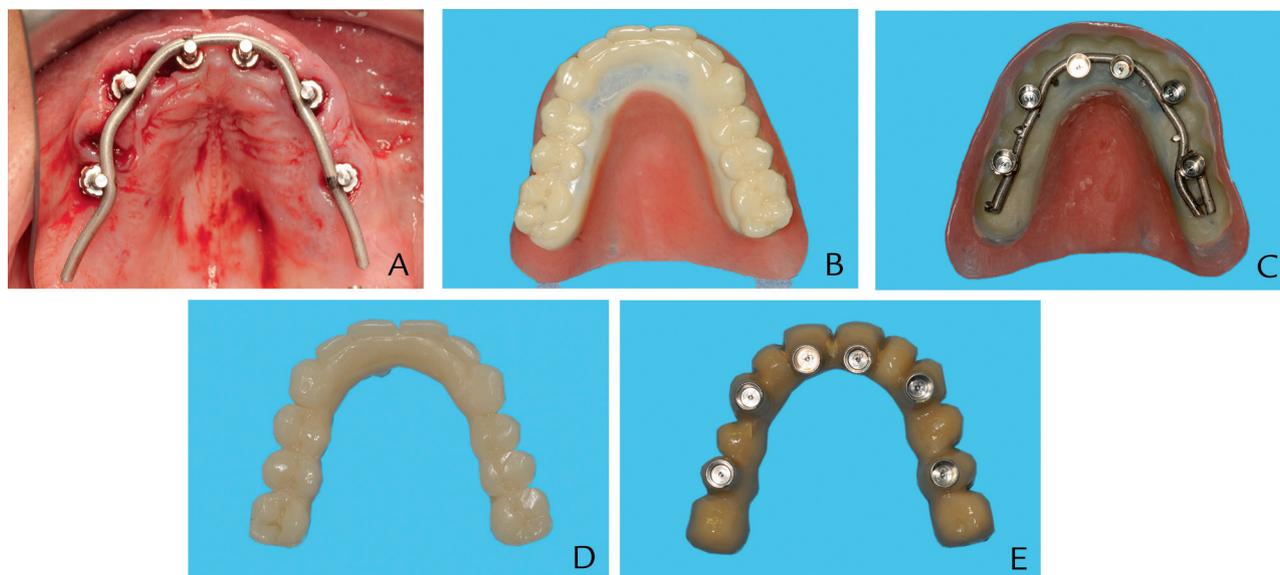
Figure 7. A, Intraorally welded framework. B, CAD-CAM milled shell. C, Reinforced framework inside CAD-CAM milled shell. D, Trimmed and polished definitive restoration. E, Cone-in-cone connections. CAD-CAM, computer-aided design and computer-aided manufacturing.

Figure 8. Postoperative appearance. A, Frontal view. B, Occlusal view. C, Frontal view at 4-month follow-up.

diameter titanium bar (WeldOne Concept; Dentsply Sirona) to replicate the shape of the titanium bar premodeled in virtual planning (Fig. 6A). Scan and import the definitive cast into the software. Match it with the plan, ensuring that the abutment angulations and the titanium bar shape are as similar as possible to those planned virtually[14] (Fig. 6B, C).

9. On the day of surgery, connect the abutments to their respective implants by fabricating resin keys and coupling together pairs of abutments and place the welding copings over the abutments. Achieve the Morse taper connection by tapping the welding copings. Weld the bar to the copings intraorally by using a welding unit (WeldOne welding unit; Dentsply Sirona) (Fig. 7A).

10. Retrieve, reinforce, airborne-particle abrade, and opacify the framework and then replace it in the oral cavity. Fabricate a shell in poly(methyl methacrylate) using a 5-axis dental milling machine (inLab MC X5; Dentsply Sirona), using information from the STL5 file (Fig. 7B, C). Reline it with dual-polymerizing composite resin (combo.lign; Bredent). Remove the restoration from the oral cavity using a fixed partial denture remover, trim, and polish (Fig. 7D, E). Place the restoration in the mouth and engage it onto the abutments (Fig. 8, Supplemental Video 1, available online).

DISCUSSION

A rehabilitation of the mandibular arch with implant-supported fixed restoration was treatment planned to enhance the occlusal stability. Because of the cost, the patient elected to postpone this procedure. On the day of surgery, once the restoration had been delivered, the occlusion was evaluated and refined with selective grinding to provide symmetrical and well-distributed contacts and to reduce horizontal forces as suggested by Crespi et al.[16]

The intraoral welding technique has been reported to be a suitable solution for stabilizing the implants for

complete-arch immediate restorations.[17-19] The copings and titanium bar are placed between the 2 electrodes of the welder. The process does not produce heat or damage surrounding tissues. Therefore, the patient does not feel pain or discomfort.[20]

In guided surgery, implants can be planned according to a restoratively driven treatment plan using radiographic guide information. If an immediately loaded fixed restoration is planned with a guided-welded approach, information about definitive prosthetic shell shape is lacking and the thickness could be underestimated. The presented workflow was developed to solve those disadvantages. When an immediate restoration supported by cone-in-cone abutments is planned with a guided-welded approach, the proposed workflow allows the dentist to virtually plan implant positions, conometric abutment height and angulations, and the location of the titanium bar more precisely, considering the available prosthetic space. If the framework interferes with relining the prosthetic shell, additional time may be needed to adjust the intraoral bar or retention could be lost. Such an event can occur from the loss of abutment parallelism because of the necessity of switching position of non-indexed conometric abutments to maintain the framework inside the prosthetic space. This accuracy in virtual planning is particularly useful when a prosthesis that fits the sockets is planned because the prosthetic space for the framework is limited.

Another problem is that the lingual surface of radiographic guide teeth is always poorly defined, and information about the emergence profile of the immediate restoration is lacking. By importing the virtual waxing information into the planning software, the ideal definitive shape of prosthetic teeth can be considered during the planning step, avoiding a bulky prosthesis. A disadvantage of the proposed workflow is that its numerous steps are time-consuming (virtual shell designing, importing, and matching) and require the use of different CAD software solutions. However, matching the virtual shell with the radiographic guide in the planning software is a predictable step.

SUMMARY

When 3D radiographic guide information is used for computer-guided implant planning, information about the emergence profile of the immediate restoration and the prosthetic shell shape and thickness is lacking. Importing the virtual waxing and virtual prosthetic shell information into the planning software ensures predictable planning of the framework shape and position. This digital workflow improves the accuracy of the prosthetic shell relining procedure when an immediate restoration supported by cone-in-cone abutments is planned with a guided-welded approach.

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Corresponding author:
Dr Alberto Maria Albiero
Via Circonvallazione Ovest 1/1
33033 Codroipo (UD)
ITALY
Email: a.m.albiero@gmail.com