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Digital implant dentistry —a workflow in five steps

Authors_ Dr Tim Joda & Prof. Daniel Buser, Switzerland

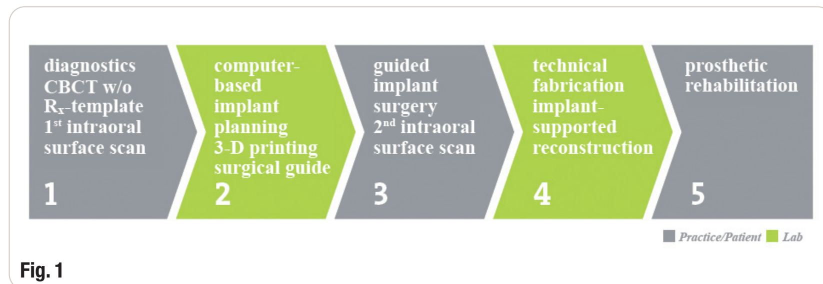

Fig. 1

_Introduction

Restoration-driven implant placement is a key factor for successful implant therapy. In this context, Computer-assisted Implant Surgery (CAIS) offers an additional instrument for treatment planning, surgical placement and prosthetic rehabilitation in an interdisciplinary team approach.

The continuous technological progress in both the computer-based development and the dental manufacturing process ensures new opportunities in the clinical workflow. DWOS, in association with Straumann, offers a powerful combination of CAIS with the established GonyX System. In addition, a fully digital pathway in a model-free approach or a combination of these workflows is now possible.

This case presentation displays insights into the current processes of CAIS with an outlook on future improvements in the digital implant workflow.

_Interdisciplinary Planning

CoDiagnostiX ensures the planning of the implant position using Cone Beam Computed Tomography (CBCT) with DICOM data (Digital Imaging and Communications in Medicine) and the subsequent transfer of the virtual situation into reality with an interdisciplinary team approach including the restorative dentist, the implant surgeon and the dental technologist.

The conventional workflow includes the fabrication of a dental set-up, a radiographic template and the secondary adaptation to a surgical template. Here, the fully digital process represents a further development: computer-assisted planning of the implant position by means of a virtually constructed prosthetic set-up and on-screen designing of an implant-guided template. The number of operational steps is shortened significantly compared to the conventional workflow.

Moreover, costly and time-intensive preparations can be avoided for the patient in advance of the CBCT. In addition, existing 3-D radiographic images should already be used, if possible.

The clinical case presentation demonstrates step-by-step the fully digital implant workflow with CAIS, including intraoral surface scanning and prosthetic rehabilitation in a five-step approach (Fig. 1).

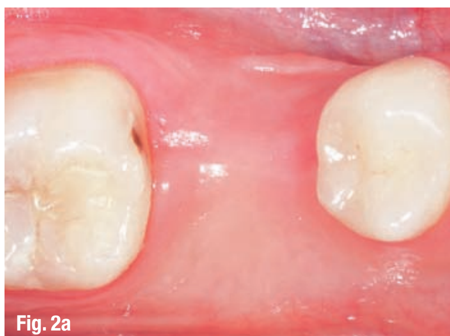

Fig. 2a

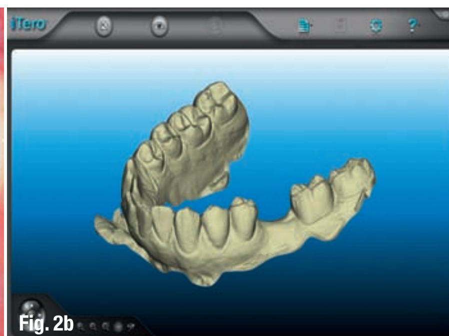

Fig. 2b

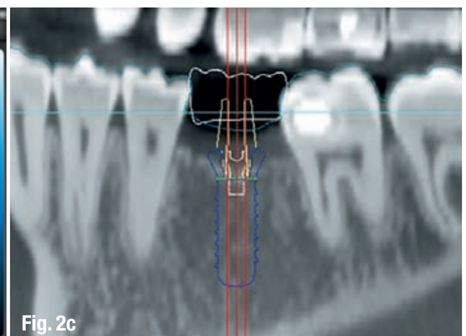

Fig. 2c

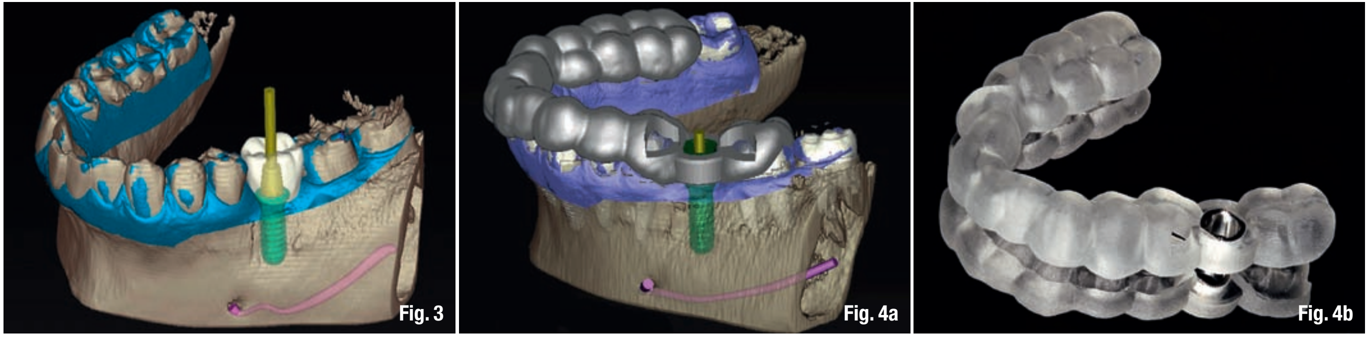
Fig. 3 Fig. 4a Fig. 4b

Step 1

3-D radiographic diagnostics are performed without any template. An intraoral surface scan (iTero™) supplements the imaging sequence. The scan allows the generation of a high-resolution portable STL file (Surface Tesselation Language) of the intraoral patient situation (Figs. 2a–c).

Step 2

The DICOM data and the STL file are implemented and superimposed in the CoDiagnostiX planning software. A virtual set-up of the prosthetic reconstruction, as well as a surgical template with optimal 3-D implant positioning can be realized using a restoration-driven backward planning concept, whilst considering the individual anatomical situation (Fig. 3).

Once the planning phase is finished in CoDiagnostiX, a 3-D printer can plot the virtual construction of the surgical template with the rapid prototyping technique without the need of any physical model. Finally, CoDiagnostiX delivers an individual drilling protocol with sequenced CAIS instruments for a safe 3-D implant placement (Fig. 4a & b).

_Surgery

Step 3

Prior to implant surgery, the plotted template is checked for a gap-free fit in the patient's mouth. Built-in viewing windows adjacent to the implant site and in contralateral position improve the level of control that can be clinically achieved (Figs. 5a & b). After anesthesia and soft tissue punch, the cortical bone is perforated with a round bur in central position.

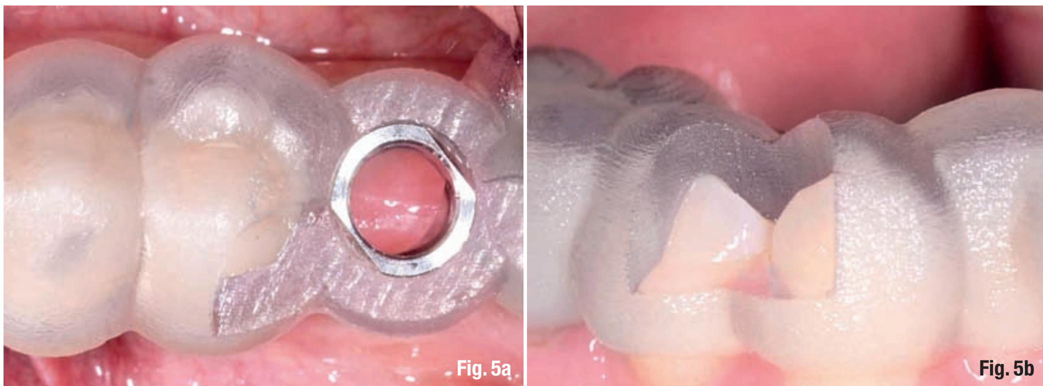
Fig. 5a Fig. 5b

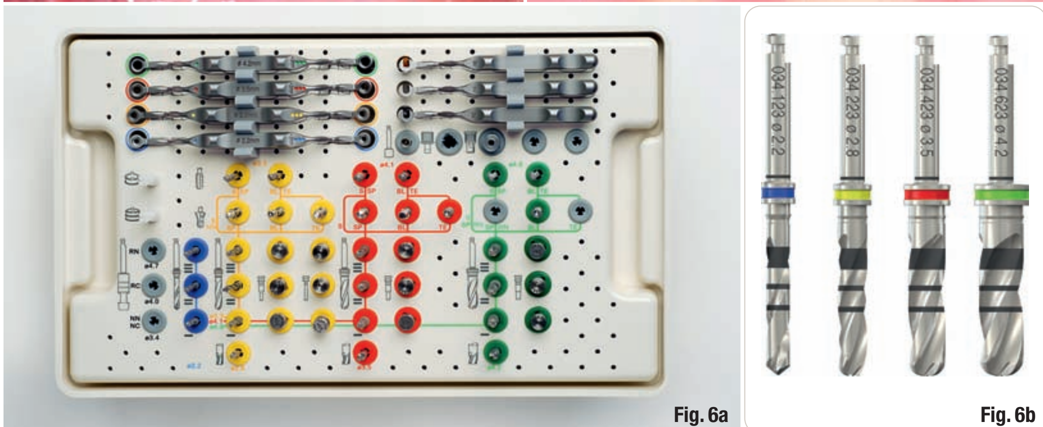

Fig. 6a Fig. 6b

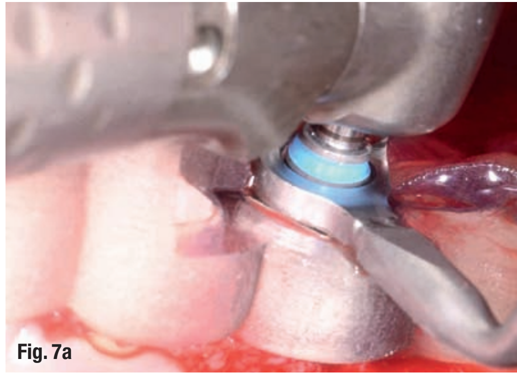
Fig. 7a

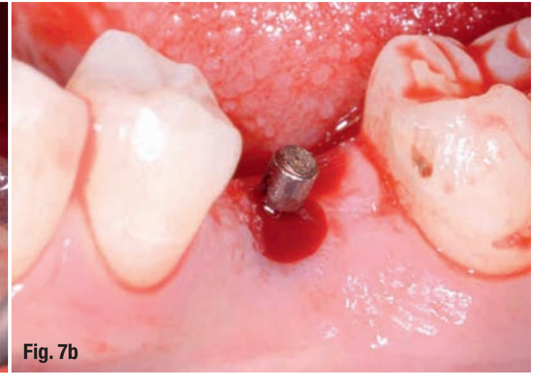
Fig. 7b

Afterwards, the preparation of the implant bed is made, successively using specialized guiding tools and corresponding spiral drills that could clinically be inserted into the slots of the sleeves. A flapless approach is only recommended if the local bone anatomy is adequate in volume, and if a wide band of keratinized mucosa is present at the implant site (Figs. 6a & b).

An implant depth gauge is placed after the first drilling to confirm accurate positioning of the osteotomy. Early error detection can be noticed at this initial stage and a possible deviation of the proposed implant position must be corrected manually (Figs. 7a & b).

Afterwards, the guided drill sequence can then be continued. The present bone density will determine, if thread cutting is necessary, or not (Figs. 8a–c). The placement of up to RN/RC-diameter-implants can be made directly, guided via the integrated 5 mm drill sleeve. Implants with larger diameters must be inserted manually by guidance of the finalized drill bed. The post-operative radiograph shows the correct prosthetic positioning of the implant with sufficient safety distance from the Nervus alveolaris interior and the adjacent dentition (Figs. 9a–c).

_Prosthodontics

Step 4

Based on an additional intraoral optical impression using an implant scanbody, a second STL file can be created immediately after implant placement. This STL file is then also implemented into CoDiagnostiX. Differences between the actual implant location and the virtually planned position can be correlated and compared (Figs. 10a–c).

Moreover, the implant-supported prosthetic suprastructure can be designed and fabricated during the healing period. All the necessary information of the actual implant position is still included in

Fig. 8a

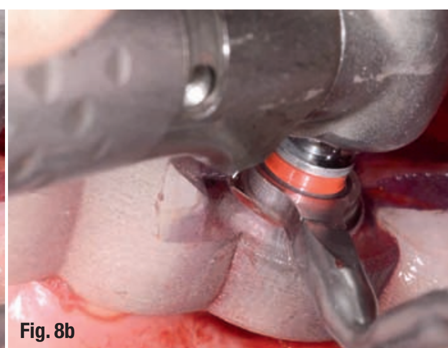
Fig. 8b

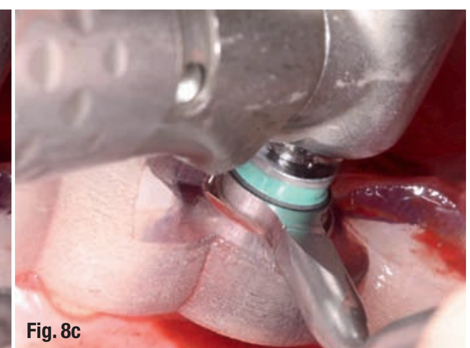
Fig. 8c

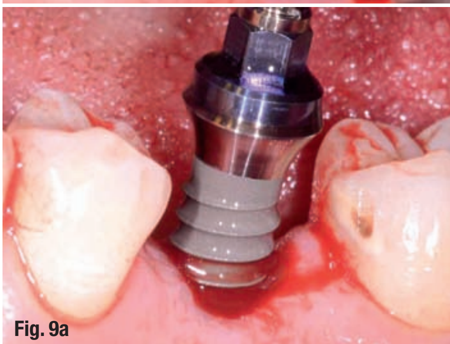
Fig. 9a

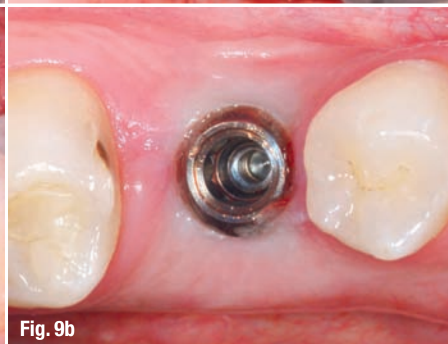
Fig. 9b

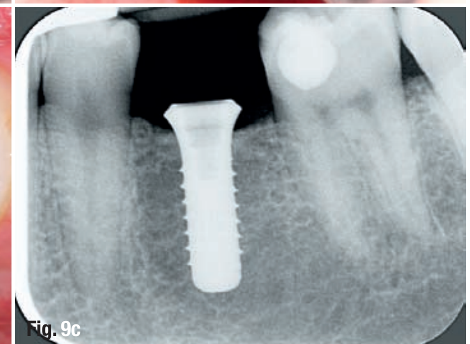
Fig. 9c

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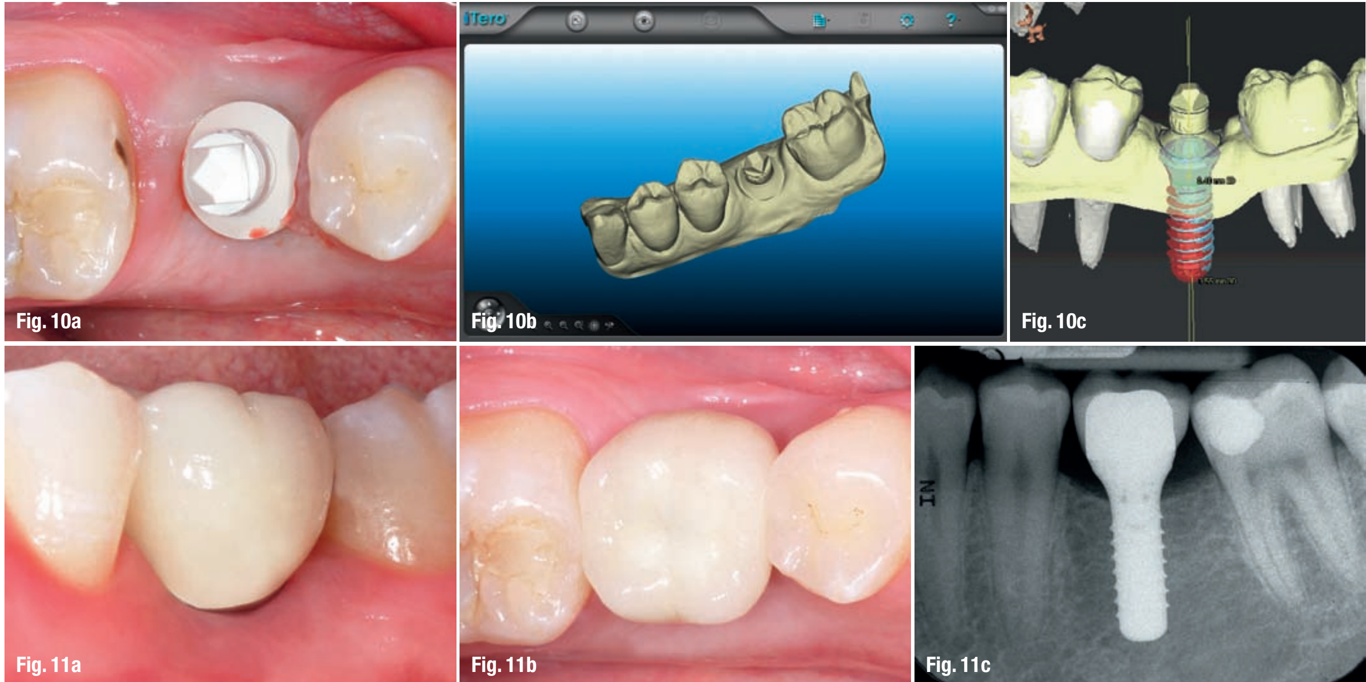
Fig. 10a
Fig. 10b
Fig. 10c
Fig. 11a
Fig. 11b
Fig. 11c

the second STL file at this time. The CAD/CAM-fabricated monolithic implant crown can be finalized based on the virtually generated patient situation in a model-free technical approach.

Step 5

The full-contour reconstruction is tried out and reveals a functional treatment outcome without the need for any interproximal or occlusal corrections and a pleasing clinical appearance (Figs. 11a–c).

_Summary

Further development in digital implant dentistry approximates the interfaces of surgical and prosthetic treatment steps: from the virtual planning, plotted on a guidance template manufacturing, to the CAD/CAM-based design, including production of the final prosthetic reconstruction.

As a part of the whole digital sequence, CAIS offers an additional tool in the interdisciplinary treatment planning. Precise and predictable treatment results can be implemented with this approach under consideration of the individual patient situation. In the full digital workflow, the overall treatment time is shortened and technical work steps can be saved in advance in a total of five stages with only three patient appointments. This novel process ensures the virtual construction and fabrication of surgical templates with a 3-D printer as well as the fabrication of monolithic implant-supported reconstructions using CAD/CAM-technology without the need for any physical models. This approach has the potential to further simplify clinical procedures in implant patients. The technique needs to be examined in clinical studies. In addition, clinical experience will demonstrate what percentage of the patient pool will benefit from this exciting technology.

_Acknowledgements

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CAD/CAM

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