Guided implant placement without conventional impressions

Authors_ Dr Jan-Frederik Güth, Dr Florian Beuer & Prof Daniel Edelhoff, Germany

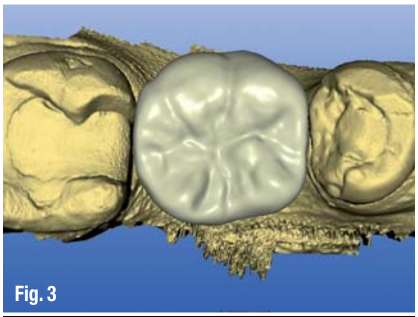
Fig. 1_Single missing tooth #36, inadequate fillings of teeth #35 and 37.
Fig. 2_Radiographic template with bite registration material.

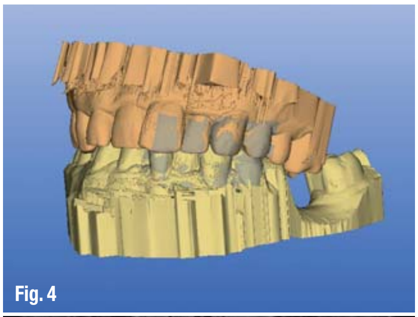
_Today, digital dentistry and CAD/CAM technology are widely used in dentistry, particularly in the field of implantology. While the last decade was entirely dominated by the CAD/CAM-supported fabrication of dental restorations, digital impressions have attracted increasing attention amongst dental surgeons and technicians in the last few years.[1, 2]

Prosthetic-oriented planning of the implant position meets the standard in implantology. Previously, this type of backward planning and subsequent navigated implant placement relied on conventional impressions. However, in recent years it has been possible to capture the clinical situation with digital impressions using intra-oral scanners, which may replace the conventional method for several indications.

In the following case study, information on the clinical situation was captured using intra-oral digital imaging. A virtual crown was designed chairside. The CAD data was combined with data obtained from CBCT. Based on optical scan, virtual crown and 3-D X-ray data, implant planning took place and the information was translated into a corresponding surgical guide.

The present case study outlines the steps based on the example of an implant in region 36 using the implant planning software SICAT Implant, the optical scanner CEREC AC Bluecam and DICOM data obtained from a GALILEOS 3D System (both Sirona).





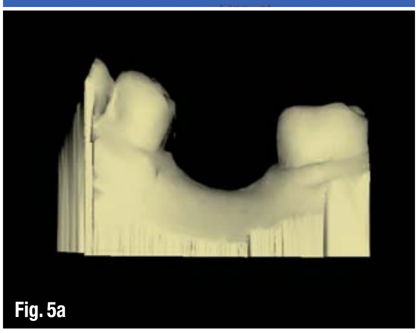


Fig. 3_CAD data of the designed crown based on an intra-oral scan with CEREC AC Bluecam.
Fig. 4_Virtual model of the maxilla and the mandible.
Figs. 5a & b_Intra-oral scan data (SSI) and 3-D X-ray data (DICOM) before fusion.

_Case presentation

The patient was referred to the Department of Prosthetic Dentistry of the Ludwig Maximilian University in Munich (LMU) after extraction of tooth #36. After an extensive case history had been taken, possible treatment alternatives were discussed. The patient opted for an implant-supported crown in region 36 along with further prosthetic work (inlay on teeth #35 and 37). Figure 1 shows the condition of the lower

Fig. 6

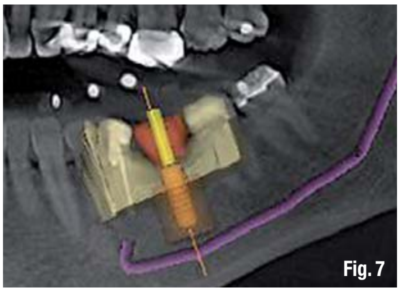


Fig. 7

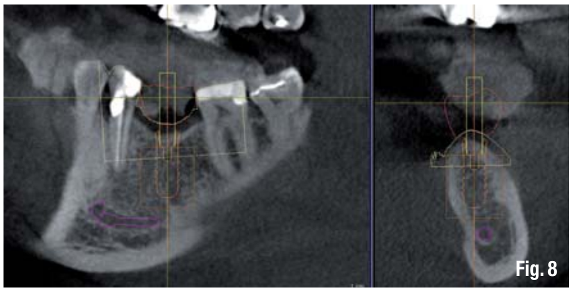


Fig. 8

Fig. 6_Merged data in planning software (SICAT). The path of nervus alveolaris inferior is marked.

Fig. 7_Selection of the virtual implant directly from the implant library of the planning software.

Fig. 8_Precise display of soft-tissue contour, safety margin around implant and drill path.

jaw before treatment. The patient categorically turned down any augmentation.

Owing to the patient's strong pharyngeal (gag) reflex and the desire for the highest possible level of safety, short incapacity periods and minimal restrictions during and after implantation, the restorative team in consultation with the patient opted for backward planning, combining intra-oral scanning and CBCT.

Method

1. 3-D X-ray imaging using CBCT: A 3-D X-ray scan was taken with GALILEOS CBCT. For future referencing, a standardised radiographic template (SICAT) was used during the X-ray scan. The template with radiographic markers was fixated in the patient's lower jaw using bite registration material (Futar Scan, Kettenbach; Fig. 2).

2. Intra-oral scan for implant planning: An intra-oral scan of the second and third quadrants including a vestibular scan was taken with the CEREC AC Bluecam during one session. A crown in region 36 (Fig. 3) was then designed based on the virtual model. The optical impression and the virtual crown were exported to be combined with the 3-D X-ray scan in the implant planning software (SICAT Implant).

3. Intra-oral scan of entire jaw: A further intra-oral scan of the entire upper and lower jaw (Fig. 4) was taken to produce a physical model for the creation of the surgical guide at SICAT. The intra-oral scan was sent to the LMU Department of Prosthetic Dentistry's laboratory via the CEREC Connect online portal, which ordered a stereolithographic (SLA) model.

To begin the implant planning, the DICOM data from the CBCT and CAD data from CEREC was imported into SICAT Implant. Using neighbouring teeth as markers, both data sets were then superimposed and merged (Figs. 5 & 6). On the basis of this information, the 3-D planning procedure took place following bone and prosthetic requirements, in compliance with safety distances. The exact gingival margin displayed within the software helped to determine the soft-tissue situation, allowing precise planning of the emergence point (Figs. 7 & 8).

In the present case, the dental team opted for the navigated placement of a Straumann Standard Implant with a 4.8 mm diameter (Straumann Guided Surgery). Once planning had been completed, the planning data was burned onto a CD and sent to SICAT along with the SLA model, radiographic template and order form.

The company uses the planning data to translate the radiographic template into a surgical guide (Figs. 8–11). Before delivery, the surgical guide is tested using high frequency testing in order to ensure that it meets the manufacturer's guaranteed production accuracy of less than 500 µm at the apical end of the implant (Fig. 12).

With the surgical guide, the dental team received a surgical protocol indicating which drills and sleeves of the Straumann Guided Surgery Kit to use. In order to ensure a minimally invasive procedure, it was decided to opt for a flapless surgery procedure. The implant bed was then

Fig. 9

Fig. 10

Fig. 11

Fig. 9_Centralised fabrication of surgical guide by converting radiographic template (right) using CNC technology.

Fig. 10_Completed surgical guide.

Fig. 11_Detailed view of drilling template: polymerised sleeve for the implantation using the Straumann Guided Surgery Kit.


Fig. 12


Fig. 13


Fig. 14


Fig. 15


Fig. 16


Fig. 17

Fig. 12_Quality control: measurement of sleeve position.
Fig. 13_Surgical guide after tissue punch *in situ*.
Fig. 14_Preparation of implant bed.
Fig. 15_Implant *in situ* without healing cap/gingival former. The punch-out hole appears oval as a result of distortion by the mirror.
Fig. 16_Implant with gingival former immediately post-op.
Fig. 17_Situation after ten-week healing period and inclusion of CEREC chairside inlays at teeth #35 and 37.

prepared using the Straumann Guided Surgery Kit, in accordance with the surgical protocol supplied by SICAT (Figs. 13 & 14). Figures 15 and 16 show the implant bed immediately after placement with and without healing cap, respectively. During the ten-week healing period, the neighbouring teeth were supplied with chairside-fabricated CEREC inlays (Fig. 17). The final prosthetic is created using a conventional impression since intra-oral scanning of implants—although technologically possible—has not yet been released by the manufacturer (Sirona).

_Discussion

Planning of the implant position based on scan data of the clinical situation was already described a few years ago. However, the data in question was gathered from extra-oral digitalised stone models.[3]

What is really interesting now for dentist and patient alike is the merging of data generated from an intra-oral scan with CT- or CBCT-generated DICOM data, as in the case presented. This provides a number of advantages: it eliminates the need for conventional impressions, the fabrication of stone models and elaborate fabrication of conventional radiographic templates by a dental technician. This means not only greater patient comfort but also a reduction in the number of patient visits.

In addition, guided implantology has additional advantages, such as greater safety; a more predictable aesthetic outcome; a minimally invasive procedure through flapless surgery, which in turn means less pain; and a reduction in downtime for the patient. A sharp outline and much more precise imaging of the gingival margin via the imported intra-oral scan also helps to make a better assessment of the emergence profile of the implant during the planning phase.

Presently, a physical model is still required to fabricate a surgical guide for navigated implantation, currently mostly made using a conventional impression. Instead, the present case used an SLA model fabricated from the intra-oral digital impression, in order to be able to work entirely without conventional impressions. Preferable for clinicians would be a fabrication of surgical guides without the need for a physical model. According to the manufacturer (SICAT), further developments in this direction are already underway and will be introduced at the IDS 2011.

In summary, it can be said that guided implantology for specific indications is already possible today without any conventional impression by combining intra-oral scans, CBCT and an SLA model._

Editorial note: A list of references is available from the publisher.

_contact CAD/CAM

Dr Jan-Frederik Güth
Poliklinik für Zahnärztliche Prothetik,
LMU München
Goethestraße 70
80336 München
Germany

jan_frederik.gueth@med.uni-muenchen.de


Any CAD
CAM
open STL-format
modular:
scanner and software or
complete process chain
incl. milling and sintering furnace
easy to use
only small space required
very good price-performance-ratio
for implants, telescopes, inlays,
onlays, etc.
IDS 2011
34. Internationale Dental-Schau
34th International Dental Show
Cologne, 22.–26.3.2011
Besuchen Sie uns!
Visit us!
Hall 10.2 / Stand L050/M051
REITEL
TRUST IN QUALITY
AnyCAD-System • www.anycad.de
REITEL Feinwerktechnik GmbH – Senfdamm 20 – D-49152 Bad Essen – Tel. +49 (0) 54 72 - 94 32-0 – Fax 94 32-40 – mail: info@reitel.com – www.reitel.com