Guided implant surgery entails using CT images of the patient to plan implant surgery through computer software. Conventional implant planning via panoramic radiographs has its limitations, as precise execution according to the surgical plan is often difficult. However, guided implant surgery can be executed accurately and precisely as planned. For guided implant surgery, a customised surgical template and a specialised surgical tool kit are needed (Figs. 1a & b).

Cone beam computed tomography

Cone beam computed tomography (CBCT) is a radiographic imaging technique used to scan the patient in 3-D. By using a CBCT device along with the requisite software, a precise and accurate examination of the patient, with realistic images, can be achieved.

Implant planning software

CBCT produces images in DICOM format, and implant planning software reads these DICOM files and reconstructs them into 2-D or 3-D images. This software provides various tools for implant planning, and as a result, the user can visualise the patient’s anatomical structures in order to plan a safe surgery.

Surgical template

A surgical template transfers the surgical planning to the patient’s mouth. In general, it is in the shape of an orthodontic splint and worn by the patient during surgery. On the surgical template, small metal sleeves are inserted in the place of the intended implant locations in order to guide drilling. It is essential for the surgical template to be fabricated to fit the patient perfectly. Several manufacturers provide surgical template fabrication services along with their implant planning software. Upon receiv-
ing the planning data obtained using the software from the clinic, the manufacturer will use the data to fabricate a customised surgical template and have it delivered to the clinic.

**Guided implant surgery kit**

In order to use a surgical template for guided surgery, a special drill kit must be used. Surgical templates and implants vary from one manufacturer to another, and various guided surgery kits are available on the market. Therefore, the manufacturer must advise which surgery kit is to be used with its surgical template.

**Case report**

A 56-year-old partly edentulous female patient presented to the clinic for evaluation of options for an implant-borne prosthetic reconstruction of the mandible. The general anamnesis did not find any noticeable problems, and the patient was not on any regular medication. The clinical examination found severe periodontal destruction around the remaining teeth in the mandible (probing depth of 6 mm) and an adequately supplied maxilla.

In order to estimate the status of the alveolar bone and to evaluate implant surgery options, a 2-D radiographic examination was recommended and, consequently, carried out using the 2-D function of a CBCT device (SCANORA 3D, Soredex). A panoramic radiograph was acquired to confirm the primary diagnosis of severe chronic periodontitis and to reassess the need for further radiographic procedures (Fig. 2). The patient was then informed about the diagnosis, therapeutic options and respective approximate costs.

**Implant planning procedure**

The patient elected for implant-borne prosthetic reconstruction of the mandible. A CBCT scan was consequently acquired (SCANORA 3D) to perform software-based implant planning for guided surgery.
surgery using a surgical template. A radiographic guide was constructed by duplicating the denture and placing eight to ten gutta-percha markers throughout the oral cavity. Gutta-percha markers should be placed at 1–2 mm intervals for the best results (Fig. 3).

Two CBCT scans were acquired: firstly, a scan of the patient wearing the radiographic guide and a radiographic guide index (bite index) to ensure that the radiographic guide was securely placed in the patient's mouth, and, secondly, a scan of the radiographic guide itself (double-scan method). The acquired data was imported into OnDemand3D software (Cybermed), and edited and merged by means of the In2Guide module (Fig. 4).

The implant planning was performed according to the nine-step procedure of the patient CT and radiographic guide option of the In2Guide module (Fig. 5). The final implant planning data was uploaded to the OnDemand3D server, and the surgical template was manufactured accordingly and delivered on time (Fig. 6).

Surgical procedure

The surgery was performed under local anaesthesia. The remaining teeth, except for one (vertical dimension placeholder), had been removed approximately six weeks earlier. The surgical protocol of a delayed implant placement was applied.

In order to fix the surgical template in place, three anchor pins were placed (Figs. 7 & 8). In accordance with the surgical template, four ICX implants (medentis medical) were inserted inter-foraminaly, applying the one-stage protocol. After the implant surgery, the last remaining tooth was removed (Fig. 9) and a postoperative panoramic radiograph was acquired (Fig. 10; SCANORA 3D).

As the next step, a provisional implant-borne prosthesis was fabricated and seated (Fig. 11). The final restoration was performed approximately three to four months later.

Discussion and conclusion

The literature supports the use of CBCT in dental implant treatment planning, particularly with regard to linear measurements, 3-D evaluation of alveolar ridge topography, proximity to vital anatomical structures and fabrication of surgical guides. Areas such as CBCT-derived bone density measurements, CBCT-aided surgical navigation and post-implant CBCT artefacts need further research.
All CBCT examinations, like all other radiographic examinations, must be justified on an individualised need basis. The benefits to the patient for each CBCT scan must outweigh the potential risks. CBCT scans should not be taken without initially obtaining thorough medical and dental histories and without performing a comprehensive clinical examination. CBCT should be considered an imaging alternative in cases in which the projected implant receptor or bone augmentation site is suspect, and conventional radiography may not be able to assess the true regional 3-D anatomical presentation. The smallest possible field of view should be used, and the entire image volume should be interpreted.

---

**Fig. 7** Surgical template and anchor pins in situ.
**Fig. 8** Radiographic control of the anchor pins.
**Fig. 9** Post-op situation.
**Fig. 10** Post-op radiographic control.
**Fig. 11** Provisional prosthesis.

---

**Authors**

Dr Jörg Mudrak, DDS, DMD
Seestraße 15
63571 Gelnhausen
Germany

Dr Michael Haas, DDS, DMD
Schillerstraße 1
99834 Gerstungen
Germany