lence in the absence of heterogeneity. The random-effects summary prevalence of 33.5% can be interpreted as the average prevalence from all studies. The predictive interval, which ranged from 4.8% to 62.3%, includes the possibility that a new study could see a prevalence of DH as low as 5% but also a possible prevalence much higher than the expected average of 33.5%.

Zeola LF, Soares PV, Cunha-Cruz J: Prevalence of dentin hypersensitivity: Systematic review and meta-analysis. *J Dent* 81:1-6, 2019

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IMPLANTS

Digital implant planning and guided implant surgery

BACKGROUND

As digital technologies have advanced, dental practitioners have recognized many areas where they can play a critical role. Implantology and implant prosthetics depend on having comprehensive diagnostic information and precise planning to achieve the desired outcome and meet the expectations of both the dentist and the patient. Using digital implant planning and guided implant surgery offers many advantages over conventional approaches. The workflow of digital implant planning and surgery and possible sources of error were considered.

DIGITAL IMPLANT PLANNING BASICS

The requirements for digital implant planning and guided surgery are 3-dimensional imaging of the anatomical structures and a precise diagnosis and prediction of potential problem areas so that the process can be tailored to the situation. The 3-dimensional radiographs includes digital imaging and communications in medicine (DICOM) data and standard tessellation language (STL) data based on an intraoral scan or a scan of a plaster cast. With this information, the procedure can be carefully planned but also modified at any time to accommodate a specific implant system or its software component. The acquisition of these data facilitates communication among the implant team members, which includes the patient, dentist, and dental technician. The visual presentation that can be achieved allows the patient to see the planned restoration and permits better communication about options and limitations.

WORKFLOW

The specific components of the digital workflow are the acquisition of basic data, data processing, design and fabrication of the surgical template, and the surgery itself.

Data Acquisition

All of the needed data can be acquired in a single visit. The STL data and DICOM data from the radiological images are superimposed on one another. DICOM is obtained by cone-beam computed tomography (CBCT) imaging or standard CTs. Field of view (FOV) must be carefully selected to obtain accurate data. The digital separation of significant structures on CBCT can be done either on an automatic or a manual setting.

Data Processing

The surgical template is generated from the STL surface data. Both it and the DICOM data are imported into the implant planning software and superimposed. Specific points are marked to align the data recorded. An incorrectly positioned implant can dramatically affect surrounding structures, so error analysis and correction are vital parts of the process.

The digital data obtained through direct production or a scanned wax-up are entered into the planning software or generated there. Implant position is aligned with the anatomical conditions or the process is reconsidered (Figures 2 and 3). When registration is successful, anatomical structures can be marked and protected. The inferior alveolar nerve is of particular concern, so the planning process should designate a safe distance of at least 1.5 mm for this nerve. Identifying bony undercuts can avoid complications.

Generally the planning software includes a database of common implants or can have their data uploaded. Based on the anatomic considerations and the characteristics of the planned restoration, a proper implant can be selected. At this point any need for augmentation procedures can be verified. If the surgeon did not personally do the implant planning, he or she should carefully

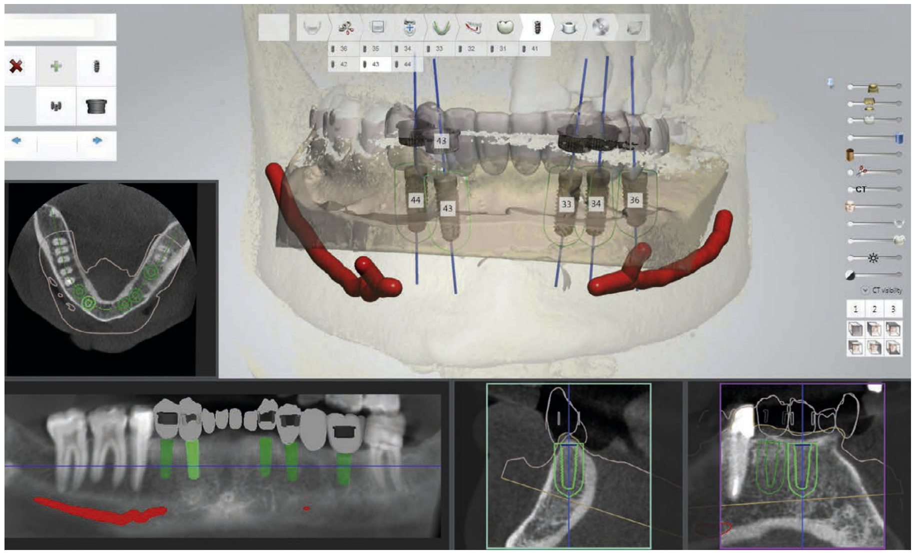

Figure 2. Marking the inferior alveolar nerve *(red)* and implant placement planning, taking into account the anatomical situation and the prosthetic pre-planning (ImplantStudio; 3Shape). (Courtesy of Schubert O, Schweiger J, Stimmelmayr M, et al: Digital implant planning and guided implant surgery – workflow and reliability. *Br Dent J* 226:101-108, 2019.)

check it and formally approve it before the surgical template is fabricated.

Designing and Fabricating the Template

The future implant positions are translated into the design of the surgical template. Either a partially guided approach or a fully guided procedure can be selected. When implant planning is approved, the software provides a planning report that specifies the type, size, and position of the implants to be placed. The surgeon is provided with the drilling protocol, which indicates the correct use of the system-specific surgical instruments.

The completed design can be exported as an STL file and converted directly into the physical surgical template. The methods used include 3D printing or rapid prototyping techniques such as stereolithography (SLA), digital light processing (DLP), or selective laser sintering (SLS). The guide sleeves must be integrated manually.

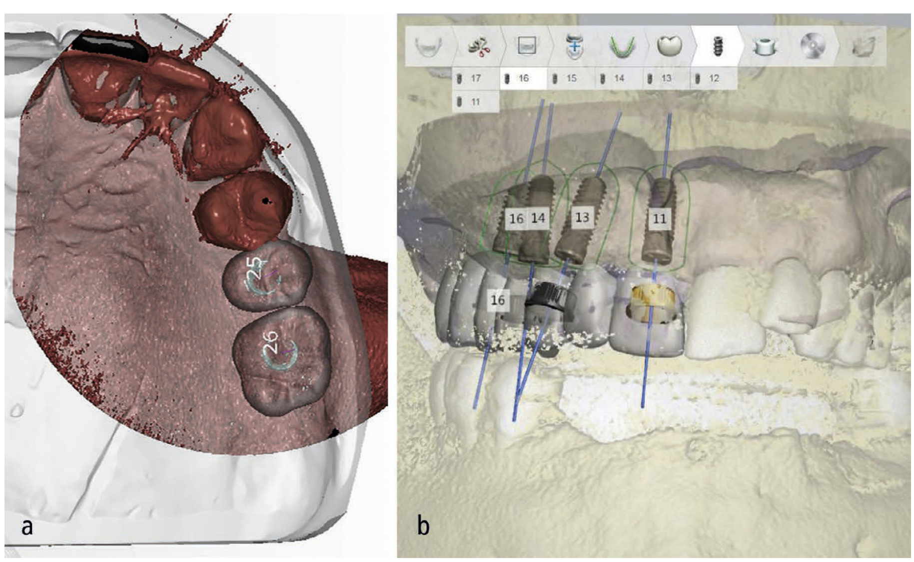

Figure 3. A, Virtual planning of the projected dental prosthesis via backward planning allows the best possible orientation of the implant from a prosthetic point of view. DICOM data are shown in red, while STL data are shown in grey (DesignCAD 6.0; Zfx). **B,** Virtual prosthetic restoration and implant alignment (ImplantStudio; 3Shape). (Courtesy of Schubert O, Schweiger J, Stimmelmayr M, et al: Digital implant planning and guided implant surgery – workflow and reliability. *Br Dent J* 226:101-108, 2019.)

Implant Surgery

The correct position of the surgical template in the mouth is verified by using special verification windows. The template should fit exactly and securely. A flap is reflected to access the bony surface or a flapless approach may be performed, in which the tissue is punched. Next, guided preparation of the implant site is done following the standardized drilling protocol, with inspections done at any point. Sufficient irrigation is essential throughout the drilling, although this can be hampered by the presence of the template. Once the implant is inserted, sutures are placed or a healing abutment or immediate restoration is inserted.

SOURCES OF ERROR

At each part of the workflow process, there are opportunities for things to go wrong. For example, the digital design and planning software relies on accurate data acquisition and processing. Artefacts, FOV, voxel size, contrast resolution, and patient movement can all limit the clinical accuracy of the CBCT scans and therefore the data collection process. When the surgical template is being manufactured, it's important to use subtractive milling to achieve accuracy rather than rapid prototyping techniques. The guided implant surgery system itself can noticeably affect the surgical outcome. The gap between the implant drill and the guiding sleeve must be carefully monitored to maintain accuracy. Extremely high or low positioning of the guide sleeve can interfere with the outcome. It has also been found that using the fully guided protocol yields more accurate positioning of the implant than partly guided surgery. Maintaining adequate positioning of the surgical template is also required for success. Anatomic features that affect outcomes include the number and location of remaining teeth. The maxilla also seems more prone to deviations than the mandible, likely as a result of differing bone density and anatomy.

A final consideration is the degree of experience of the surgeon. Experienced surgeons tend to have more accurate results when performing guided surgery. In particular, there is better alignment of planned and achieved implant positioning. Human error can also enter into the equation, sometimes accounting for inaccurate positioning of the guide or faulty use of the equipment.

Clinical Significance

A careful combination of obtaining accurate anatomic information with doing precise virtual prosthetic planning yields a more reliable process of digital implant placement. With the resulting high degree of predictability, the prosthetic outcome is more likely to provide excellent function, esthetics, and phonetics. The technology makes the process safer and more efficient than conventional procedures and also accomplishes the task in less time. It's important to select an experienced surgeon to achieve the best results and avoid complications.

Schubert O, Schweiger J, Stimmelmayr M, et al: Digital implant planning and guided implant surgery – workflow and reliability. *Br Dent J* 226:101-108, 2019

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Preventing peri-implantitis

BACKGROUND

Dental implants supporting dental restorations after tooth loss have shown long-term success, but biological and technical complications can occur. The most challenging biological complication is peri-implantitis, which can progress to loss of the implant. Preventing peri-implantitis should be an important goal for clinicians so that both the occurrence and the severity of the problem can be minimized. The development of peri-implantitis, the treatment of this disease, and its prevention were the focus of a three-dimensional film presentation.

PERI-IMPLANT HEALTH AND DISEASE

The natural teeth are anchored to the alveolar bone and gingiva through a periodontal ligament and supracrestal connective tissue fibers. The fibrous attachment between the root cementum and alveolar bone is formed as part of the root formation process. A thin junctional epithelium continuous with a sulcular and oral epithelium forms the interface between the gingiva and the tooth crown.

For implants, the hard and soft tissues are formed through wound healing. The tissue injury process occurring during osteotomy and implant installation produces a series of reactions in bone, including the degradation of the bony compartment just lateral to the implant. Several weeks are required for the remodeling processes of the hard tissue interface with implants to be accomplished. New bone is then in contact with the implant through osseointegration. Healing of the peri-implant mucosa takes several weeks as well. It includes the formation of junctional epithelium