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

Reprints available from O Schubert, Dept of Prosthetic Dentistry, Univ Hosp, LMU Munich, Goethestr 70, D-80336 Munich; e-mail: Oliver.Schubert@med.uni-muenchen.de

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

and adaptation of the connective tissue to the implant material. No fibrous attachment exists in the connective tissue–implant interface, but the collagen fibers of the peri-implant mucosa align parallel to the implant's long axis. Blood vessel density is reduced in the supra-crestal connective tissue of the peri-implant mucosa compared to the natural tooth's tissue compartment.

When it is healthy, peri-implant mucosa lacks any visible signs of inflammation. The epithelial and connective tissue interface portions seal sufficiently to contribute to the healthy state. However, neither implants nor natural teeth can shed microorganisms like the oral mucosa can, so bacteria tend to attach and form a biofilm, especially in the gingival or peri-implant mucosal sulcus compartment. This biofilm builds up, becoming a complex matrix of bacteria, polysaccharides, and proteins, and creates its own biological system that is regulated by bacterial interactions. Unless the biofilm is removed from the implant-crown restoration, a host response in the mucosal connective tissue lateral to the sulcular and junctional epithelium develops.

Peri-implant Mucositis

The response provoked by the accumulation of the biofilm, or plaque, on implants is an inflammatory reaction that results in peri-implant mucositis. This disease is defined as an inflammatory lesion of the soft tissues surrounding an endosseous implant in the absence of loss of supporting bone. The lesions are located in well-defined connective tissue compartments lateral to the junctional/pocket epithelium. They contain dense quantities of vascular structures, plasma cells, and B- and T-cells. The lesions can be present for extensive periods of time without progressing, but a subsequent disruption of the equilibrium of the lesion, such as a failure to carry out maintenance cleansing, can lead to increased inflammation and expansion into lateral and apical directions. With the apical progression into the supracrestal connective tissues and loss of contact between the connective tissue and the implant, the soft tissue seal around the implant is lost and the patient can then develop peri-implantitis.

Peri-implantitis

The characteristic signs of peri-implantitis are inflammation, bleeding or suppuration on probing, increased probing depth, and radiographic signs of bone loss. Although the process is similar to periodontitis around natural teeth, the 2 conditions differ in their onset and patterns of progression. The onset of peri-implantitis can occur early on after implant placement. If left untreated, it will progress in a nonlinear, accelerating pattern and at a rate considerably faster than periodontitis.

Histopathological features give insight into the potential differences between the 2 diseases related to host response. Peri-implantitis lesions can have significant amounts of plaque in the pocket compartment, but the pocket epithelium does not cover the entire pocket dimension of the mucosa (Figure 1). The apical

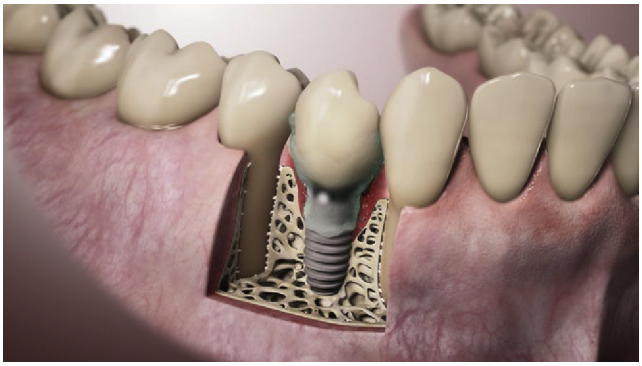

Figure 1. Screenshot from the film illustrating peri-implantitis. (Courtesy of Berglundh T, Jepsen S, Stadlinger B, et al: Peri-implantitis and its prevention. *Clin Oral Imp Res* 30:150-155, 2019.)

third of the pocket appears as uncovered, severely inflamed connective tissue facing a massive amount of microorganisms living on the implant surface. In addition, there is no periodontal ligament around implants so the inflammatory cell infiltrate is not separated from the crestal bone. Finally peri-implantitis lesions are more than twice as large as periodontitis lesions and contain more numbers and greater densities of plasma cells, neutrophils, and macrophages than periodontitis lesions. Thus the lack of root cementum, periodontal ligament, and supracrestal attachment fibers with implants create the histopathological differences between peri-implantitis and periodontitis.

TREATMENT OF PERI-IMPLANTITIS

The goal of treatment in peri-implantitis is to resolve the lesion and arrest the progression of bone loss. This is similar to the goal of treatment for periodontitis. However, the achievement of this goal is challenging. Nonsurgical methods of removing the biofilm in the supramucosal area around implants and comprehensive instruction in self-performance of infection control are fundamental parts of this treatment. However, for severe cases, surgical procedures may be required. These access procedures are designed to resolve the connective tissue lesion. Outcomes are better with nonmodified implant surfaces, and no chemical agent better than saline solution has been found successful in decontaminating the implant surfaces. The technical difficulties involved in treatment as well as the number and amount of resources required make prevention a better option than treatment.

PREVENTION OF PERI-IMPLANTITIS

The major aspects of peri-implantitis prevention are thorough information about and training in self-performed oral hygiene measures around implants. Along with this a personalized supportive therapy program for follow-up that provides for all the patient's specific oral needs and potential risk factors or indicators must be in place. Patients who have had severe periodontitis, poor plaque

control, and no regular maintenance care after implant therapy tend to be at increased risk for peri-implantitis development. Smoking and diabetes have been investigated as additional risk factors but the data remain inconclusive. Regular recall visits should be scheduled and include a clinical examination plus a radiological examination, as indicated, to detect peri-implant disease. Peri-implant tissues will require probing to assess bleeding on probing and to monitor changes in probing depths and mucosal margin migration. Clinicians should obtain baseline radiographic and probing margin measurements after completing implant-supported restorative therapy.

Berglundh T, Jepsen S, Stadlinger B, et al: Peri-implantitis and its prevention. *Clin Oral Imp Res* 30:150-155, 2019*Reprints available from* T Berglundh, Dept of Periodontology, Inst of Odontology, The Sahlgrenska Academy, Univ of Gothenburg, Göteborg, Sweden; e-mail: tord.berglundh@odontologi.gu.se

Clinical Significance

The key characteristics of the peri-implant diseases peri-mucositis and peri-implantitis are important to recognize. Although they are similar to the characteristics of periodontal disease in natural teeth, the altered anatomy related to implant placement makes it more likely to develop a buildup of microbial biofilm and to alter the host-response balance sufficiently to lead to disease. Preventing peri-implantitis should be a primary goal of clinicians who provide implant therapy.

LOUPES

Coaxial alignment

BACKGROUND

Surgical loupes are magnification devices dental and medical professionals wear to observe structures that can't be readily viewed with the naked eye. Usually these loupes consist of frames and carrier lenses similar to those of regular glasses or protective goggles but have binocular magnifying lenses mounted on the frames or fixed in the carrier lenses. The 3 types are lens-mounted (FLM) with full vertical adjustability (FVA) surgical loupes; FLM with limited vertical adjustability (LVA) surgical loupes; and through-the-lens (TTL) surgical loupes. Full vertical movement of the mounted magnifying lenses can be achieved with FLM plus FVA surgical loupes. FLM with LVA surgical loupes cannot achieve full vertical movement but can have the hinges bent between the magnifying lenses and frames to adjust vertically. Because the magnifying lenses of TTL surgical loupes are fused directly into the lenses, they cannot be adjusted vertically except with slight bending of the frames and nosepieces. Surgical loupes are being used more than in the past because they provide visual and postural benefits. However, if the surgical loupes are misaligned, clinicians can suffer postural detriment and reduced quality of care. Research has identified the critical criteria for selecting and adjusting surgical loupes to be working distance, declination angle of the oculars, and coaxial alignment, which refers to the vertical alignment between the magnified image and the observed object. Visual discrepancy can occur when the loupes are misaligned, as can chromatic aberrations of the magnified image. If these aberrations occur, clinicians might experience bright sparks of differing colors in the magnified view. A gap in

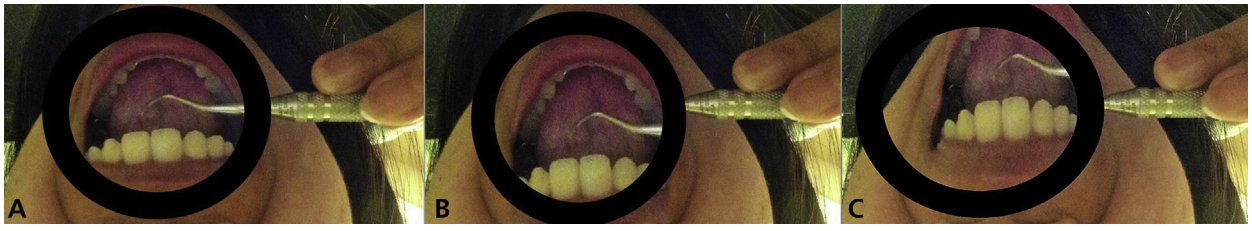

Figure 2. Coaxial alignment versus misalignment. **A,** The magnified image of a dental instrument and the actual instrument in coaxial alignment. **B,** The clinician's view when the magnified image of a dental instrument is lower than the actual instrument because of surgical loupe coaxial misalignment. **C,** The clinician's view when the magnified image of a dental instrument is higher than the actual instrument because of surgical loupe coaxial misalignment. (Courtesy of Wen W, Kanji Z, Laronde D, et al: Out of the loupe: The prevalence of coaxial misalignment of surgical loupes among dental professionals. *J Am Dent Assoc* 150:49-57, 2019.)