Implant Complications: Biomechanical and Esthetic Considerations—A Prosthodontist's Perspective

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ABSTRACT

Implant placement has continued to gain acceptance as a viable solution for the treatment of missing teeth, serving as an alternative to dentures or bridges. However, clinicians must be aware of and capable of handling complications that may accompany the placement of dental implants. Complications can range from prosthetic problems stemming from misalignment of implants, to fixed/removable prosthesis-related complications, to screw-connection impediments. This article describes and illustrates how a multidisciplinary team approach can be employed to optimize implant treatment planning to successfully overcome these issues.

As the use of dental implants rises, clinicians must be cognizant of potential complications that may ensue. Implant complications fall into several main categories: implant misalignment as a prosthodontic complication; fixed/removable prosthesis-related complications; screw-connection complications; and loss of osseointegration. This article will focus on the first three of these problems.

Misalignment of Implants as a Prosthodontic Complication

Improper implant placement is among the biggest problems encountered by clinicians. Prosthodontic complications arising from improper implant alignment commonly require treatment by a highly trained prosthodontist or restorative dentist. Some of these patient cases can be saved, while, unfortunately, others cannot.

Although prosthodontists are capable of saving many complicated implant cases, the clinical results may still remain esthetically compromised. As opposed to heroic attempts to restore a misaligned implant, there are times when implant removal is a better solution. In the challenging case depicted in Figure 1 through Figure 4, after implant removal resulted in a large bony defect, the best option for the patient was bone regeneration. This involved waiting an additional 6 to 9 months to regenerate the bone in the site, followed by implant placement. Achieving outcomes such as this one requires that procedures be performed correctly. Ideally, they must be thoroughly planned, and implants should be placed using guided surgery.

Less impressive results can be seen in the case shown in Figure 5 and Figure 6, in which implants were placed too close together, resulting in bone loss between the implants. Although the clinician placing the implants was pleased with the result because of acceptable function, it is our opinion that clinicians must be extremely careful when placing several implants next to each other in the esthetic zone. According to Tarnow et al in

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an article in 2003, "Clinicians should proceed with great caution when placing two implants adjacent to each other in the esthetic zone. In most cases, only 2 mm, 3 mm, or 4 mm of soft-tissue height (average 3.4 mm) can be expected to form over the inter-implant crest of bone."[1]

Designing and creating a provisional restoration prior to implant placement can help assure excellent soft-tissue contour. A crucial element in the presurgical fabrication of a provisional restoration is finalizing the ideal position of the implant platform. This highlights the importance of collaboration between the prosthodontist and surgeon. Guided surgery can help the clinician transfer the planning to the patient. A well-planned case will result in the fabrication of an esthetic provisional restoration (Figure 7 through Figure 9). To achieve this, the clinician must create an esthetic emergence profile for the restoration. **[Author: Is this edited correctly?]**

An example of complications arising in an otherwise functional implant is when the implant is incorrectly placed from a buccal-palatal aspect. As can be seen in Figure 10 and Figure 11, the prosthodontist was left with the challenge of developing a way to cover the implant that would be acceptable to the patient. The incorrect horizontal implant position left few options for improvement.

Fixed/Removable Prosthesis-Related Complications

UCLA abutments have given clinicians a better "exit strategy" when complications arise. The advantage of this type of abutment is its flexibility, which enables it to be customized. Today, fully customized abutments and milled computer-aided design/computer-aided manufacturing (CAD/CAM) abutments help clinicians save cases in more sophisticated ways.

The emergence profile of a single-tooth implant abutment has a significant effect on the esthetics of the final restoration. Digital technology offers the prosthodontist a variety of options, including having the ability to customize the abutment in order to fully match the natural emergence profile.

A 2010 article from the *Journal of Dental Biomechanics* compared a customized CAD/CAM abutment to standard abutments. The article pointed out that custom abutments have a stress value that is about 30% lower than standard abutments.[2] This is clearly an advantage because the custom abutment causes less stress on the implant–abutment connection, placing less stress on the peri-implant bone.

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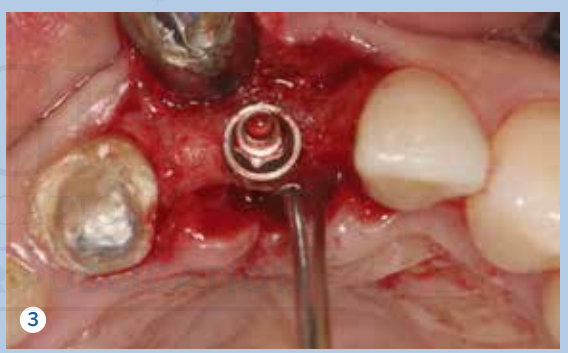

FIG 1. Incorrect vertical and buccal-palatal implant placement. **FIG 2.** The implant was removed and a new implant was placed in the correct vertical and horizontal position using computed tomography (CT)-guided surgery. **FIG 3 AND FIG 4.** Newly placed implant in the correct vertical and horizontal positions.

In a case involving a 22-year-old woman with congenitally missing lateral incisors (Figure 12 through Figure 14), neither soft-tissue augmentation nor bone augmentation had been performed, resulting in a restorative challenge. However, a customized zirconia abutment helped create a natural emergence profile, which is still functioning well more than 10 years later. This case supports the authors' opinion that zirconia abutments and restorations are preferable in esthetically challenging cases. Titanium abutments can be hidden without esthetic compromise if the patient has considerable soft-tissue thickness.[3] However, digital technology has limitations in creating abutments of widely varying angulations.

Clinicians should adhere to recommended ratios of implant abutments and crowns to avoid long-term biomechanical problems. A progressive overload over time can cause an implant, abutment, or fixation screw to fracture. This often results in a screw coming loose, one of the most common prosthetic complications. Implant screw breakage is not quickly or easily managed. At times it may take hours for a clinician to remove a fractured screw. If an implant is damaged in the process, it may require removal.

There are many theories regarding the management of forces on implants. Excessive force is considered one factor contributing to peri-implant bone loss. A 2005 editorial reported a causal relationship "between the incidence of marginal bone loss next to an implant and occlusal overload."[4] It stated that a force-management approach is necessary. A 2013 *Clinical Oral Implants Research* article described a composite resin onlay bonded to a zirconia implant abutment, which presented "similar dynamic response to load when compared to teeth with simulated periodontal ligament."[5]

A major topic of discussion in prosthodontics concerns restorative methods absorbing forces on implants. It is thought that this might contribute to the long-term success of the implant restoration. One possible option is a restoration made of a zirconia framework, with prefabricated composite veneers manufactured in a specific way, resulting in an extremely smooth surface to which plaque can only adhere to minimally. After the setup is finished, it is scanned, and the framework is designed on a computer. It is then milled, the veneers are bonded to the framework, and additional composite is added to individualize the final restoration. This is a very cost-efficient process, which is beneficial in satisfying the economic needs of many patients today.

Screw-Joint Complications

Beyond the difficulty in retrieving broken screws, there may be screw-joint complications exacerbated by full-zirconia abutments or titanium implants. A study from Sailer et al that compared four different groups of abutments, however, showed that

FIG 5 AND FIG 6. Example of implants being placed too close together (Fig 5), resulting in a suboptimal outcome (Fig 6). **FIG 7 THROUGH FIG 9.** Design of a provisional restoration based on the patient's anatomy and smile, which will result in an esthetic emergence profile. [Author: Please provide more detail of what is being shown in each of these three figures. Also, is the caption correct as is?]

the type of connection significantly influenced the abutment strength. Superior strength was achieved by means of an internal connection with a secondary metallic component.[6] Due to the uncertainty of an adhesive's longevity, the abutments could encounter long-term problems.

Concerning the implant–abutment interface, a biomechanics study by Hermann et al reported on the advantages of abutments that had been laser-connected to an implant as opposed to those that had been screwed to an implant. The investigators found that the "screwed" group lost significantly more bone than the "laser-connected" group, suggesting that implant–abutment stability is highly important in avoiding complications.[7]

Implants with a platform-switch design have both advantages and disadvantages related to stress. The design, which transfers stress from the implant–bone interface to the interior of the implant, relieves cortical bone strain but increases the strain and stress within the abutment, possibly leading to screw loosening or breaking. Therefore, if a platform-switch implant is used, a biomechanical, extremely stable implant–abutment connection is clearly favorable. The platform switch also provides clinicians with additional soft-tissue thickness to maximize esthetic results.

The esthetic advantage of a platform-switched implant with a customized zirconia abutment is demonstrated in the clinical case of a 24-year-old woman who received a provisional restoration after implant surgery (Figure 15 through Figure 19). The provisional was over-contoured, putting too much pressure on the peri-implant soft tissue. A soft-tissue necrosis developed due to inadequate blood supply to the affected area. The prosthodontist was able to save the case by using a customized zirconia abutment and a zirconia crown.

A report in the literature correlated problems with the depth of an implant margin with cement, noting that x-rays are not always a reliable method for cement evaluation.[8] Our experience has shown cement-related implant problems as well. In an immediate-load study, the patient group with cemented provisional crowns demonstrated cement-related issues, while patients whose provisional restorations were screw-retained had no problems.[9]

Material Problems

While breakage associated with some materials is a prosthodontic problem, there are minimal failures or complications associated with materials produced via CAD/CAM. It is estimated that by 2017 US dentists will have placed more than 25 million CAD/CAM-manufactured crowns/bridges. Adoption of digital impression-taking systems and rapid prototyping/3-dimensional (3-D) printing will further fuel the dental prosthetics market to reach a value of more than $16.3 billion by 2017.[10]

FIG 10 AND FIG 11. Incorrect buccal-palatal implant placement. [Author: Please explain what is being shown in Fig 11. Describe the covering on the implant?] **FIG 12**. Implant placement replacing congenitally missing lateral incisors. **FIG 13.** Standard metal abutments showing discoloration of the peri-implant soft tissue. **FIG 14.** Improved result with customized zirconia abutments and zirconia crowns.

Team Approach

Clearly, a multidisciplinary team approach optimizes implant treatment planning. The use of technology is essential in ensuring the accurate placement of components while minimizing complications. It also improves time management. Utilizing modern laboratory technology to create CAD/CAM restorations and employing such clinical technology as cone beam computed tomography (CBCT)-based virtual implant planning, stereolithographic-produced or milled surgical guides, and prefabricated provisional restorations can significantly reduce chair time and result in more cost-effective treatment with improved outcomes.

Prosthodontists not originally trained in newer technologies should strive to keep as up to date as possible, for the sake of both their patients as well as the entire dental community.

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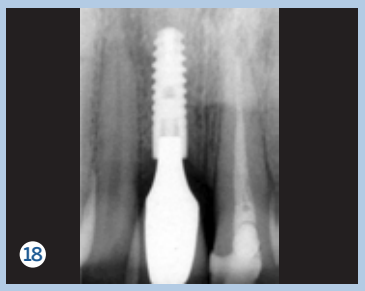

Fig 15. Clinical situation after 1 week. **[Author: Please expound. "...after 1 week following placement of abutment and crown? ..."]** **Fig 16.** Clinical situation after 5 weeks. Both interdental papillae have been lost. **Fig 17.** Clinical situation after 6 weeks. The final restoration has been placed. **Fig 18.** Radiographic situation after 1 year. Note there was no peri-implant bone loss. **Fig 19.** Clinical situation after 1 year. Due to the stable cortical bone and the healthy adjacent teeth the soft tissue slowly regenerated.