Prosthodontic considerations


Chapter 6

The prosthodontic section of the 1997 ITI Consensus Conference in Vitznau, Switzerland, examined a broad spectrum of issues related to the prosthodontic phase of dental implant therapy. Topics included diagnosis and treatment planning, considerations for the use of ITI prosthodontic components, management of the partially edentulous patient, management of the edentulous patient, implant occlusion, and the use of narrow- and wide-body implants. The management of partially and totally edentulous patients will be discussed in separate papers. This paper is written so that each major consensus point discussed by the prosthodontic section is the first sentence of a paragraph. The remainder of each paragraph serves as background information or justification for the consensus statement. It should be noted that agreement on all points was reached by voting within the prosthodontic section. Many of the consensus statements were reached unanimously, while some were reached through compromise and split vote. Not all of the points presented here were presented to the plenum session on the final day of the conference.

Introduction and general comments

Dental implant therapy is performed primarily for the purpose of replacing missing teeth and associated structures. Implant surgery, therefore, is preprosthetic surgery, and as such must be performed to satisfy prosthodontic needs and indications. Without prosthodontic indication there is no rationale for the surgical placement of dental implants beyond occasional use for orthodontic anchorage.

The success of the prosthodontic phase of implant therapy is clearly dependent upon proper execution of the surgical phase. Both surgical and prosthodontic phases of treatment require careful pretreatment diagnosis, evaluation and planning. Preservation of remaining natural structures, improved functional and esthetic outcomes and pa--
tient satisfaction are the goals of dental implant therapy.

Dental implant therapy should be considered for the treatment of partial and complete edentulism and as an adjunct to other disciplines such as orthodontics, orthopedics and maxillofacial prosthetics. In many circumstances, dental implant therapy is clearly the method of choice for the replacement of missing teeth (Rizzo 1988).

**Diagnosis and treatment planning**

Implant therapy is contraindicated in patients with ongoing active dental/periodontal diseases. This statement is based upon the premise that the first goal of dental care is the diagnosis, prevention and treatment of oral diseases. The replacement of tissues damaged or destroyed by disease – by definition, prosthodontics – is the secondary goal of dentistry (VanBlarcom 1994). It must be assumed, therefore, that any treatment planning process involving dental implant therapy is based upon the above premise that disease control and prevention are the primary objectives of that treatment plan and that the prosthodontic/restorative phase of treatment, discussed here, is secondary (DeVan 1952).

The position, diameter and number of implants are determined by prosthetic requirements andatomic considerations. This statement elicited extensive discussion from the surgical group at the consensus conference. The initial statement, as presented at the conference, stated that position, diameter and number of implants are determined by prosthetic requirements. The basis of this statement was the initial premise of this paper, that dental implant surgery is pre-prosthetic surgery and must satisfy prosthetic requirements. The number, position and size of implants would therefore be based upon the anticipated needs of the planned prosthesis. It was pointed out by the surgical group, however, that while the prosthodontic requirements of rehabilitation dictate implant choice and position, in many cases anatomic limitations of the intended surgical site will also affect the final choice, number and placement of implants. The original intent of the prosthodontic statement should not be lost, however. Prosthodontic treatment planning is the primary determining factor in decisions of implant choice and placement.

Functional and esthetic treatment success depends upon adequate diagnostics, indications and treatment planning. The intent of the prosthodontic section of the consensus conference and therefore of this paper was not to provide a treatise on diagnosis and treatment planning. However, the participants agreed unanimously that the foundation of successful dental implant therapy is thorough diagnosis and treatment planning of both the prosthodontic and surgical phases of treatment. The need for careful planning, in other words, cannot be overemphasized.

Treatment planning and communication with patients must include alternative methods for tooth replacement. The principle of informed consent signifies that the patient has been thoroughly informed of all treatment options, including advantages and disadvantages of each option, prior to the commencement of treatment. The basic right of the patient to participate actively in treatment planning decisions is paramount to the ethical practice of all areas of medicine and dentistry. Informed consent becomes especially important when the treatments being provided are elective in nature and when the anticipated results of those treatment options vary greatly in cost as well as in

**Fig. 6.1.** Solid abutments for use with the cemented type of restoration. From left: 4 mm solid abutment, 5.5 mm solid abutment, 7 mm solid abutment, solid abutment for the ITI Wide Neck implant.

**Fig. 6.2.** Cross-section through an ITI solid screw implant with a screw-retained restoration based upon the Octa abutment concept.
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Functional, cosmetic and psychological outcome. Dental implant therapy is but one option for the replacement of teeth and must be presented as such to all patients. Failure to inform patients of all treatment options is a frequent cause of malpractice litigation.

Considerations for the use of ITI® prosthodontic components

Screw retention vs cementation (Figs 6.1 & 6.2)

Retrieveability is not a prerequisite for long-term success of implant-supported restorations. The assumption that implant-supported restorations must be retrievable is the result of historical dependence upon screw-retained components for early dental implant systems (Zarb & Jansson 1985). Practitioners who have been restoring dental implants for many years were initially exposed to and trained to use a system that did not have options available for cement-retained prostheses. As the number of implant systems began to expand, so did the availability of alternative methods of retaining restorations. The concern that implant-retained restorations must be retrievable is not based upon evidence that implants or the restorations that they support fail at a higher rate than those supported by natural teeth. The two most common causes of failure of a tooth-supported restoration are caries and periodontitis (Glantz 1989). Neither of these occurs with implant-supported restorations. The fact that conventional restorations on teeth are at risk for the above-mentioned modes of failure, yet are permanently cemented without consideration for retrieval, is not consistent with the rationale that implant-supported restorations must be made to be retrievable.

Cementation is mainly indicated for single unit and short span restorations where retrieval is not likely to be necessary. The advantage of retrievability is least important for single-tooth and short span restorations, where component failure is less of a risk. Avoidance of the need for screw access holes makes esthetic restoration simpler and will not affect the occlusal design of the restoration. In addition, the components required for a cemented restoration are likely to be considerably less expensive than the corresponding screw-retaining components. When one considers that a very common complication of implant prosthodontics is the loose occlusal screw, elimination of this type of complication by eliminating occlusal screws would seem to be a clear advantage of the cementable approach. The introduction of an impression coping and implant analog system as well as the option for implant level impression-making with the Synocta system have greatly simplified the impression and laboratory procedures for the ITI® system (Figs 6.3 & 6.4). The simplicity of fabricating a cemented restoration on dental implants has the potential for making implant therapy available to more patients, as dentists not inclined to offer dental implant services because of the perceived complexity of the components may be induced to offer straightforward cemented restorations on dental implants.

The cemented approach has the potential for being more passive than screw retention. The question of whether a misfitting prosthesis can cause failure of osseointegrated dental implants has not been answered (Carr et al. 1996). It must be assumed, however, that misfit has the potential to cause failure of an implant-supported restoration, either through destruction of the bone-to-implant interface, mechanical failure, or loosening of the components of the implant-prosthesis complex. The use of screws to retain a prosthesis permits the introduction of extreme forces through screw...
tightening that are likely to be of much greater magnitude than the patient could possibly generate through occlusion. These forces introduce permanent and unremitting strain between implants that will not be dissipated through orthodontic shifting of the implants. The long-term effects of such forces on stability and health of implants and the restorations they support are not understood, but they are not likely to be in any way beneficial. The fabrication of a restoration that is not screw-retained but rather is cemented is less likely to induce significant strain between implants. A prosthesis fabricated on slightly oversized dies, as with a die spacer, and accurately related to the abutments has the potential of being completely passive to a degree that could not likely be attained with screw retention.

Long span and full arch restorations may be either cemented or screw-retained. While there is clearly no scientific evidence that cementation of extensive metal-ceramic restorations is more susceptible to failure than similar-sized screw-retained restorations, it must be assumed that the larger the prosthesis the more likely it is to be subject to mechanical failure. This is true for both tooth-supported and implant-supported restorations. Longer spans are technically more difficult to fabricate to fit precisely, are more prone to flexure failure of connectors or metal-ceramic bonds, and are at an increased risk of abutment loss simply due to the increased number of abutments supporting the restoration. The principles of periodontal prosthesis for natural teeth dictate retrievability to allow for modification of the prosthesis as necessary, as well as to maintain access for oral hygiene procedures. These principles can be carried forward to the extensive full arch type of restoration if desired, either through screw-retained designs or through provisionally cemented designs. The prosthodontic section of the consensus conference was clearly of divergent opinion on the issue of screw retention vs cement retention for long span prostheses.

Screw retention is preferred in situations of deep submucosal implant shoulder placement (3 mm or greater). The rationale for this statement is based upon the concern for two potential sources of irritation or inflammatory response related to implant restoration. First, with shoulder placement of three millimeters or more subgingivally, it is unlikely that the practitioner would be able to thoroughly and completely clean the excess cement from the restoration after placement. This could cause an inflammatory response of either acute or chronic nature that might potentially affect long-term health of the tissues surrounding the implant. Second, prefabricated machined components are generally considered to possess fit characteristics superior to those created with the lost wax method of casting. A rougher, less precisely fitting casting might also be a source of subgingival irritation adjacent to an implant restoration.

In situations of extended cantilevers and/or limited interocclusal space, screw retention is recommended. Cantilevered restorations are thought to be increasingly prone to mechanical complications, simply because of the types of forces they are subjected to. For this reason, screw retention/retrievability is recommended. In situations of decreased vertical space between the implant and opposing dentition, screw retention would likely offer increased retention to a cemented design, and is indicated.

Cement used may be either temporary or permanent. The preference of the practitioner to maintain retrievability versus the uncertainty of the predictable functional life span of provisional cements will determine the choice of cement used. At present there is no literature describing the relative retentiveness of various permanent and provisional cements when used between metallic surfaces. Opinions were expressed that some provisional cements seemed to function more like permanent cements when used to lute metallic restorations on metallic abutments. Stated differently, cements that are intended to be minimally retentive on natural teeth may be found to be too retentive in the implant situation.

**Abutment and occlusal screw placement**

Verification of osseointegration must be ascertained prior to or during abutment connection. The determination of successful clinical ankylosis either by radiography, percussion, mobility testing or a combination of these should be undertaken at the abutment connection visit. Early determination of failure to integrate reduces unnecessary treatment and shortens the time until corrective procedures such as placement of additional implants or modification of the treatment plan can be introduced. The subject of baseline periodontal probing of the implant at the abutment connection appointment was not brought up during the prosthodontic section workshop but was discussed during the plenum session. Agreement as to the necessity or even the desirability of this procedure as a diagnostic tool for determination of the health status of dental implants was not reached. Further research is clearly indicated in this area (Apse et al. 1991; Chaytor et al. 1991; Isidor 1996, 1997).

Abutment connection is a prosthetic and not a surgical procedure. Abutment selection for the ITI® dental implant is a prosthodontic decision.
The choice of abutment clearly follows the restorative treatment plan but may be modified by anatomic considerations such as depth of implant shoulder, implant angulation and potential for access screw visibility. An important consideration for ITI® implant abutment placement is the lack of a temporary or “healing” abutment system. Two-stage implants are frequently fitted with healing abutments by the surgeon at second-stage surgery, and these are subsequently changed for permanent abutments by the restorative dentist following soft tissue healing. The elimination of a second-stage surgery permits placement of the final abutment initially following the osseointegration period. As mentioned above, the choice of abutment type must be a restoratively driven decision. An abutment connection radiograph taken to determine complete seating of the abutment to the implant is not needed or indicated with the ITI® implant system. The abutment/implant interface is at or near the mucosal level and the connection between abutment and implant is not rotationally specific, i.e. it is not dependent upon the alignment of an internal and external hex or some other interlocking configuration. Complete seating is assured with proper torquing of the abutment into the implant (Sutter et al. 1993).

Abutment placement should be carried out without the use of cement. The friction-fit (Morse taper) of the abutment seating into the implant will only occur with metal-to-metal contact. The 1995 ITI® Consensus Conference Report contained a statement that cementation of the abutment into the implant is recommended. This is clearly not the case, as introduction of cement into the 8 degree tapered interface between the abutment and implant will cause a 180 micron vertical displacement of the abutment, assuming a 25 micron film thickness of cement. This cement film would subsequently be subjected to the functional loads placed upon the restoration, and potential dissolution or physical breakdown of the cement could occur, leading to abutment loosening (Fig. 6.5).

Abutments should be tightened to 35 Ncm. Counter torque on the implant is not necessary. The manufacturer’s recommendation of 35 Ncm torque to seat the abutment Morse taper should be followed in all instances. Placement should be performed with the Straumann manual torque control device. While counter torque to prevent dislodgment of the implant from the bone is required for some implant systems, particularly those with machined surfaces, it is not necessary for the rough-surfaced ITI® implant.

If an abutment is removed after having been torqued to place, it should not be reseated but should be replaced by a new one. While there is no clinical evidence available to suggest reduced strength or reduced ability to remain tight for abutments that are reinserted and torqued into the implant a second time, it is recommended that abutments not be reseated once removed from the implant.

Properly tightened abutments are acceptable for single-tooth restorations. Tightening to 35 Ncm provides sufficient resistance to rotational dislodgment for all single-unit restorations. These restorations may be either cemented (permanently or provisionally) or screw-retained.

Occlusal screws should be tightened to 15 Ncm. The manufacturer’s recommendation for screw-retained restorations that the titanium occlusal screws be tightened to 15 Ncm using the torque control device should be followed routinely.

Impression-making

Accuracy is of primary importance to achieve passively seated restorations. Elastomeric impression materials such as polyvinylsiloxane and polyether rubber are recommended for final impressions. Verification of prosthesis accuracy is considered to be imperative for the long-term stability of implants and the restorations they support. Visual examination, radiography, placement
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with a single screw and checking for spring back of the restoration are all methods used for evaluating the accuracy of prosthesis fit. The use of a polyvinylsiloxane fit-checking material may provide the greatest level of accuracy in most clinical situations.

Provisionalization

Placement of provisional restorations following implant placement and during the healing phase should not functionally load the implant(s). The protocol for the use of ITI® dental implants dictates a period of nonloaded healing prior to placing the implant in function. While several papers have reported on the efficacy of immediate loading for osseointegrated dental implants, it cannot be recommended as the standard approach at this time (Schnitman et al. 1997; Tarnow et al. 1997).

Following healing and after abutment placement, the abutment and the implant shoulder should be protected either by protective caps or by temporary restorations. By preventing incidental contact with a denture base or other hard object, the intended level of precision fit between components can be maintained. Titanium is not a hard metal and should be protected from possible contact with hard objects.

The benefit of progressive loading is currently undetermined. While an effort to gradually increase functional loading up to normal functional levels makes intuitive sense, the ability of the clinician to actually create and control a situation in which the loading of an implant can be gradually increased is, at best, questionable. The research to date in this area does not support the need for progressive loading (Ogiso et al. 1994).

Implant occlusion

Basic principles

There is no evidence-based, implant-specific concept of occlusion. Occlusal concepts and philosophies are not based upon scientific research, regardless of whether one is discussing natural teeth or dental implants. The concepts that have been popular for the restoration of natural teeth have been justified by purely empirical methods and have held up well to the test of time. Dentists utilizing dental implants to replace missing teeth have extrapolated those same empirical methods to dental implant occlusion without giving thought to whether those methods are appropriate or even safe for implant-borne restorations. Given this lack of evidence and in spite of the fact that the historical basis of occlusal restoration on osseointegrated dental implants is minimal temporally, the need for some guidelines to work with is obvious. The following statements are made with this understanding.

The concept of freedom in centric should be considered when creating an occlusal scheme for an implant-supported restoration to minimize potential excursive prematurities and maximize patient comfort.

Excursive contacts should occur on natural teeth whenever possible. There is no evidence that excursive or nonaxial loading is harmful to the interface of osseointegration between living tissue and the surface of an implant (Celleti et al. 1995). It is generally agreed, however, that nonaxial loading of implant components puts them at greater risk for mechanical failure through micromovement or flexure fatigue. This is likely to be a greater concern with a two-stage implant system that depends upon a hexagonal implant-to-abutment connection than with a connection with a large surface area of metal-to-metal contact between components such as the ITI® press fit design. The presence of
proprionceptive innervation in the periodontal ligament of natural teeth would seem to make the tooth a more desirable guiding surface for excursive contacts compared to the ankylosed implant with no proprioceptive capability.

The decision to create canine guidance or group function in a partially edentulous implant situation should be based upon the needs of the patient rather than any preconceived philosophy of occlusion.

For implant restorations opposing complete dentures, an occlusal scheme that will favor stability and retention of the complete denture (such as bilateral balance) should be utilized.

As a general rule, occlusal considerations for dental implants do not differ from those advocated for natural teeth. There is no evidence that alteration of current occlusal concepts is necessary when restoring dental implants.

Bruxing patients are at increased risk for complications in all restorative procedures. However, bruxism per se is not an absolute contraindication for dental implant therapy. Preventive measures such as the use of a habit appliance and protective nightguard should be considered. It must be acknowledged that parafunctional habits may be undetected preoperatively.

Use of narrow-body and wide-body implants

Narrow-body implants are well suited to placement in situations where the available alveolar bone is not of sufficient width for placement of standard diameter implants and when ridge augmentation is not otherwise indicated. The narrow-body, narrow-neck implant is best suited for placement in single incisor replacement situations that are too narrow for the standard implant shoulder (Fig. 6.6). Caution should be used when considering placement of narrow-body implants in the posterior part of the mouth where the forces of mastication are much higher than in the incisor area. They should never be used for single-tooth replacements in this area. If narrow-body implants must be used in the posterior part of the mouth they should be rigidly splinted together and, if possible, they should be splinted to larger diameter implants.

Wide-body implants are primarily indicated for placement in the posterior part of the mouth when broad alveolar width is available (Fig. 6.7). They are also indicated for immediate extraction placement in situations where extraction sites are larger than the standard diameter implants. Wide-body implants should be considered when anatomic structures limit the length of implant choice but there is sufficient width to permit a large diameter implant. The increased diameter provides increased surface area for osseous contact and will more than compensate for shorter implant length.

References


