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## Implant Management of Posterior Partial Edentulism

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A total deficit of the periodontal ligament can be reliably and routinely rectified with implant-retained/supported prostheses. This is possible because anterior edentulous zones are more likely to offer quantitatively and qualitatively favorable host sites with a virtual absence of anatomic challenges compared to posterior zones. Furthermore, an altered resultant pathogenicity in edentulous intraoral microorganisms appears to be favorably different from that of partially edentulous microorganisms, especially if the latter evolved in the context of a history of periodontal disease. Consequently, the loss of multiple teeth (as opposed to total loss), particularly in the posterior zones, used to be regarded as rather challenging. This is certainly not today's clinical mindset, given the abundant and promising literature, including meta-analyses, which attests to the successful implant management 
 Table 1
 Management Considerations for Kennedy Class I and II

 Partial Edentulism
 Feature

Justification for intervention Patient age and health of dentition in terms of function and esthetics As an integral part of temporomandibular disorder/arthritis management To avoid teeth-related sequelae: drifting, extrusion, wear, traumatic occlusion Context for surgical considerations Systemic health and smoking behavior Proximity of anatomic structures: maxillary sinuses, inferior alveolar canals Bone quantity and quality

Potential for increased force concentrations

of posterior partial edentulism. This report highlights prosthodontic educators' ongoing concerns (Table 1) for managing edentulous posterior zones in an effort to provoke debate on the determinants of successful treatment outcomes with the osseointegration (OI) technique.

#### **Review of Treatment Considerations**

Between 1983 and 2005, the Implant Prosthodontic Unit multidisciplinary team at the University of Toronto documented clinical outcomes from all implant treatment interventions for both partially and completely edentulous patients. We reconciled the specifically applied Brånemark protocols with established clinician- and patient-mediated criteria and with studies from other university centers. Ultimately, we identified a number of salient considerations for making informed decisions when prescribing routine treatment for Kennedy Class I and II partial edentulism.

#### Systemic Health and Smoking Behavior

A number of published theses and other reports suggest that patients at risk for cardiovascular disease, osteoporosis, controlled diabetes, and hypothyroidism are not at greater risk for implant failure. However, smoking behavior appears to pose a greater risk for increased failure or loss of OI, as well as a decreased bone maintenance level. While the results are reassuring overall, their strength is often limited by retrospective designs and small study populations. As a result, the variable effects of systemic conditions on specific changes in the jaws remain imperfectly understood. Increasing evidence on the heterogeneity of the human skeleton is also a strong reminder of the likely inappropriateness of extrapolating the results of animal models regarding surgical innovations and the healing of OI implants across different host sites and the age and gender spectrum.

#### Imaging and Prognostic Technologies

The profession's ability to reliably assess selected host sites has grown exponentially as a result of advances in radiologic imaging technology. Three-dimensional bone quantity visualization is now routine, and a skillful surgeon can harness the information to ensure a perfect reconciliation between prosthodontic designs and surgical solutions. Other technological attempts to produce instrumentation that reliably measures and prognosticates long-term OI effectiveness, such as torque tests and resonance frequency analysis, have not been equally successful, in spite of the popular perception that they eclipse experience-based clinical judgment.

# Implant Selection: Size, Number, Placement, and Surface

The original Brånemark protocol of 5 to 6 implants in either arch, with each implant at least 10 mm long, proved to be an extraordinarily successful formula for managing edentulism with a fixed solution. An abbreviated version of the formula was required for the posterior zone, hence the introduction of shorter, longer, and wider implants and the strategy of attaching 1 or 2 implants to a reliable natural abutment tooth, such as a canine. Offsetting implant sites whenever permitted by the residual ridge width has also been encouraged. Earlier concerns regarding tilted implants or nonaxial loading situations have been largely neutralized by extensive clinical experiences. A correlation between a favorable ratio of host trabecular bone and implant width has been proposed, and the argument favoring more and longer implants continues to be clinically endorsed. Single implants as additional overdenture-type supports for distal extension removable partial dentures have also been proposed and generally adopted.

Rough surface implants have virtually eclipsed machined implants. The notion underlying this change is laudable and supported by strong evidence of earlier and more extensive implant stability in situ. It is also argued that this fact precludes the routine need for a second surgical stage, and even encourages earlier or immediate loading in selected situations. However, it is prudent to add that long-term outcome studies comparing the 2 different surfaces using identical protocols in matched population groups and surgical sites have not been forthcoming. The lingering question then becomes whether presumed improved longitudinal clinical outcomes are really the result of better science as opposed to product promotion.

### Failure Concerns

A lack of scientific rigor in the reporting of clinical long-term outcomes for the different implant systems has led to incorrect conclusions about the cause of implant failure or loss of OI. The pathogenesis of periodontal disease is frequently ascribed to implant loss in spite of profound differences between OI as an induced healing response and the biologic evolution of a periodontal ligament. A better understanding of the complex healing events elicited by the OI protocol, as well as the possible influences (such as occlusal overload) on its integrity, is necessary to ensure that strategies for periodontal treatment are not automatically applied to implants presumed to be suffering from a periodontitis-like condition. The doctoral dissertations by Joke Duyck in Leuven (2002) and Marco Esposito in Göteborg (1999) provide provocative insights on this topic and suggest a multifactorial etiology for loss of OI. It should also be emphasized that even when numerous variables are controlled for in reported studies on this topic, documentation of the presence or absence of associations do not automatically prove causality.

#### Surgical Virtuosity

Good surgical skills and protocol application underscore the successful results of implant treatment in the posterior zones. However, surgical virtuosity that is unmatched by long-term outcome documentation risks usurping the entire objective of providing the necessary evidence to ensure reliable prognoses. An enlarged and promising list of traditional preprosthetic surgical interventions-block onlay grafts, ridge splitting, distraction osteogenesis, sinus lifts, lateralization of the contents of the inferior alveolar canal, etc-must be proven to be reliable and advantageous for routine application. However, surgical developments are almost invariably ahead of the routine proven-application curve, with the sinus lift as an excellent example. This in itself is a brilliant notion that has catalyzed numerous surgical variations and is even supported by published meta-analyses. While this suggests a virtual failure-proof technique, a recent review (Watzek 2005) underscored the importance of rigorously analyzing published claims. He pointed out that important parameters such as aging, systemic disease, lifestyle features, staged surgeries, vertical height of residual bone, aborted or failed sinus grafting procedures, etc, must be included in meta-analyses to ensure that the technique's true merits are objectively established. A similar caveat applies to the current emphasis on regenerative treatment modalities. This appears to be an exciting area for development and routine application, since the idea of developing complex bone scaffolding for customized 3-dimensional site renewal would be a boon for host sites with severely compromised morphology. However, it appears that the promising available biotechnology is not currently matched by bioengineering design rules, which are still being established. Consequently, while small deficit sites are reported as readily regenerated, the efficacy and effectiveness of rebuilding larger sites must be regarded as still being at the trial stage. Victoria Franke Stenport's thesis (2002) is also worth reading on this topic.

### Loading Protocols in the Partially Edentulous Patient

There is ample evidence to support a single-stage surgical approach when this is judged to be routine, and even when immediate loading of implants in the posterior zone is planned. Though reported results are commendable, they are limited to short- to mediumterm studies that employ various research designs. Consequently, some shortcomings are present, such as lack of standardization, limited implant and patient numbers, use of various implant designs with diverse surface topography, and variable management of deficient implant host sites. The criteria employed to analyze treatment outcomes also tend to be uneven and do not conform to those proposed at international consensus conferences.

#### Table 2 Determinants of Successful Osseointegration

Patient/site specific healing capacity Adherence to prescribed protocols Operator skill Ecologic concerns Coping with challenges to the induced healing response Improved implant surfaces Immediate loading expectations Site development

#### Conclusions

Brånemark implants and other implant systems are widely reported as being successful treatment alternatives to removable partial dentures for managing posterior partial edentulism. Table 2 lists the factors prosthodontists should consider to enhance their chances of clinical success. The introduction of new clinical protocols, particularly surgical protocols, continues to enlarge the scope for the technique's routine and versatile application. Ultimately, the discipline's commitment to *primum non nocere* continues to rely on experience and skill, and, whenever possible, on results from ongoing rigorous documented trials.

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