# Chapter Eleven

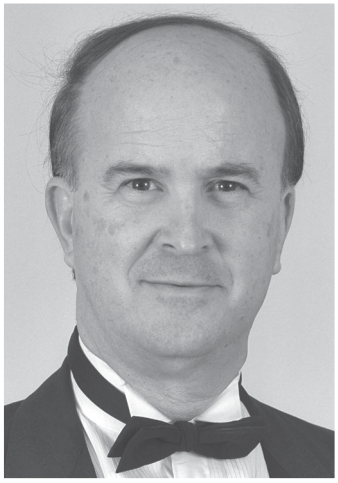
George A. Zarb, John P. Zarb, Jeffrey E. Rubenstein, Harold W. Preiskel, and Jonathan P. Wiens

## The Impact of Osseointegration

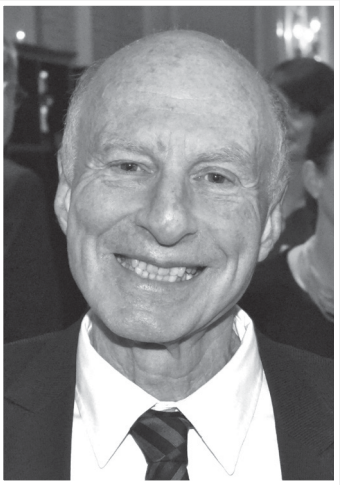
Linking dental prostheses to the facial skeleton via intra-osseous implants seemed like an effective way to overcome the inherent disadvantages of removable prostheses. However, numerous pioneering efforts failed to provide documented, predictable, and morbidity-free outcomes,[1] and the American Dental Association Council on Dental Material's recommendations on the subject gradually changed in accordance with the availability of robust basic and clinical research on the topic.[2-5] The catalyst was Per-Ingvar Branemark's 1977 publication on osseointegration, which confirmed the feasibility of placing alloplastic tooth root substitutes in human jawbones.[6-9]

Academy Fellow George Zarb organized the 1982 Toronto Conference on Tissue-Integrated Prostheses[10-16] and introduced the global dental academic community to the method of inducing a controlled interfacial osteogenesis between commercially pure titanium dental implants and host bone. It was followed by international research endorsement of the merits of the technique for treating both maladaptive and adaptive edentulous patients, and a new era of prosthodontic management was launched. Subsequent research publications encouraged the expansion of implant prosthodontics as a valid treatment option for most partially edentulous patients, especially maxillofacial ones, provided that the necessary systemic and local criteria for implant pre-prosthetic surgery plus additional expenses could be met. A brief summation of the technique's impact on the prosthodontic treatment spectrum may be considered under three distinct headings.

▲ Professor Per-Ingvar Branemark, Honorary Fellow



▲ Dr. George Zarb



▲ Dr. Harold Preiskel

Complete Edentulism

The advent of osseointegration added a new dimension to therapeutic possibilities for patients who were prosthetically maladaptive or presented with resorbed edentulous mandibles.[17] Implant-treated patients quickly realized that a fixed prosthesis was a profound life-enhancing intervention, and most were overjoyed with their treatment's outcome.[11-16] Academy Fellow Harold Preiskel noted that the resultant euphoria was, however, tempered by the realization that an exclusive surgically driven approach led to irregularities of the occlusal plane, unusual tooth positions, questionable esthetics, and unpredictable effects on the supporting ridge of an opposing complete denture.[18-21]

Similar surgically driven approaches produced greater complications in the maxillae, where the pattern of residual ridge reduction often resulted in implant placement palatal to optimal positioning of the artificial teeth. This led to reduced lip support, risk of excessively proclined prosthetic teeth, or even large gaps between prosthesis and mucosa. Nevertheless, the security and confidence felt by patients usually outweighed such associated drawbacks.[22-25]

Favorable treatment outcomes also moved the concept laterally by underscoring the versatility of implant-supported/retained overdenture.[26-31] The approach expanded the technique's clinical research application to include a number of required supporting implants and the possible need and methodology for their connection as well as the necessary number and type of retention units. A new assessment of surgical judgment focus emerged as it became unacceptable to place oddly angled implants in so-called convenient bony sites and which often led to placement of prosthetic teeth as an afterthought.[30] The main purpose of the therapy as replacement for missing teeth was belatedly recognized—pre-prosthetic surgery should be planned with the desired prosthodontic result in mind.

Clinical progress also occurred with diverse anatomical challenges addressed by pioneering surgical and prosthodontic protocols. Site preparation protocols—ridge augmentation, regenerative techniques, and sophisticated grafting approaches—were introduced and gradually provided scope for providing better-looking functional prostheses. Furthermore, subsequent digital protocols expedited and simplified overall planning and execution. The realization that the area of induced interfacial osteogenesis did not have to match that of the lost periodontium also led to a reduction in supporting implants placed for fixed prostheses.

Partial Edentulism

Loss of anterior and posterior teeth from dental diseases, traumatic incidents, and congenital anomalies were and continue to be compelling reasons for implant prosthodontic treatment. Yet, traditional management with short-span adhesive prostheses or diverse designs of fixed/removable prostheses risk time-dependent compromise of the oral ecology, resulting in unpredictable consequences and the need for frequent dental interventions. Academy Fellow John Zarb noted that applying the information

and experience gleaned from management of edentulous patients to the partially edentulous predicament was initially challenged by the presence of adjacent teeth, soft tissue changes, and control of occlusal forces. However, it also provided exciting new scope for safe, minimally invasive, and predictable solutions that did not seriously impact oral ecological concerns. Younger patients with intact virgin teeth were no longer confronted with the need for removal of healthy enamel—a non-renewable resource—for fixed prosthodontic solutions or to struggle socially with removable prostheses.[32-37] Advances in implant macro and micro design expanded scope for their potential use in partially edentulous sites with limited bone quantity and quality, while diagnostic information via Cone Beam Computerized Tomography (CBCT) helped determine optimal prescriptions for implant lengths and diameters in host sites limited by bone volume and/or the presence of important anatomic structures. The development of powerful diagnostic software permitted incorporation of the CBCT plus intra- and extra-oral scans to plan implant placement in a prosthetically driven way. Achieving primary stability at the time of implant placement in carefully selected patients' healed and/or extraction sites became a realistic goal without compromising esthetic and functional outcomes.

▲ Dr. John Zarb

Initial routine prescriptions of traditional cement or screw-retained metal ceramic restorations often led to inconvenient time-dependent challenges (porcelain chipping, screw loosening, inadequate excess cement removal, etc.). Consequently, novel dental materials were introduced, and CAD/CAM technology expanded to encourage design and manufacture of transitional and definitive restorations using diverse biocompatible materials. Today's partially edentulous patients have access to approaches that address the perceived barriers to implant care: cost, time required to complete treatment, and fear of the entire process. Patients are now beneficiaries of impressive advances in the expansion of digital technology that ensure accessible, appealing, minimally invasive, and diverse implant prosthodontic solutions.

▲ Dr. Jeffrey Rubenstein

Maxillofacial Patients

Prior to osseointegration being applied as a clinical tool for oral rehabilitation, "prosthodontics" was defined as being subdivided into three categories of care—fixed, loose, and looser—with the latter defined as "maxillofacial prosthodontics" as described by Academy Fellow Jeffrey Rubenstein. Osseointegration represented the "deal breaker" in that categorization of implant-based maxillofacial rehabilitation, and, in some regard, trumps what one would deem a fixed prosthodontic rehabilitation. Recent innovative efforts introduced interfacing surgical reconstruction procedures of anatomically compromised maxillae or mandibles via vascularized grafting with implant-based prosthodontic rehabilitation. This was done after eradicating malignant or benign disease as well as putting back what

was congenitally missing or traumatically compromised. The approach further advanced osseointegration to not only reconstruct, but to also meaningfully rehabilitate individuals in need of being "made whole again."[38-49]

▲ Dr. Stephen Parel

Swedish advances in craniofacial implant applications were reported by the Goteborg research team in the 1970s. They demonstrated support and retention for extra-oral prostheses and expanded scope for inclusion of osseointegration in maxillofacial prosthodontics and were advanced by Academy Fellow Steve Parel. Furthermore, use of craniofacial implants to retain a bone-anchored hearing aid (BAHA) led to improved auditory function for those with neurosensory hearing deficits resulting from trauma, tumor ablation, or congenital mal-development.

Current application of virtual planning for reconstruction/rehabilitation, first described by Dennis Rohner, et. al., rapidly streamlined overall clinical protocol.[50] The conventional and rather protracted sequence of surgical reconstruction, followed by a healing period, then placing implants, and then an integration period and the required steps associated with prosthesis fabrication, have now been superseded by an improved, more precise and efficient methodology for reconstruction/rehabilitation efforts.

It is a very exciting time to be involved with implant-based maxillofacial rehabilitation. Rapidly expanding bio-technological advances will offer even more viable management options for individuals whose head and neck anatomic integrity has been compromised because of necessary surgical interventions for oncologic, traumatic, or congenital reasons. An enhanced life quality will be provided for these individuals, and more especially where the restoration of oral function is prioritized.

Osseointegration is an outgrowth of a compelling and robust research base. It ushered in a new, exciting era for optimal management of most prosthodontic patients' needs. In the last forty years, the scope of prosthodontic education, research, and clinical treatment has been transformed, as evidenced by the reassessment of the accreditation standards and ubiquitous publications on implant studies that furthered understanding and possible uses of osseointegration. The remarkable outcomes with implant-supported prosthodontic treatment were willingly embraced by both the patients and health-care providers; in the process, traditional removable and fixed prosthodontic treatment has been eclipsed by implant prosthodontics, which is widely regarded as providing a new standard of care for replacing missing teeth.

From Shakespeare's time until the late twentieth century, the last age of man might well have been "sans teeth, sans everything," but not anymore! When arriving at a mutually informed decision regarding implant treatment, dentist and patient must keep in mind a thorough appreciation of the procedures involved along with their risks and evidence-based, time-dependent outcomes. Biological, functional, personality, and fiscal considerations may therefore preclude one option or the other. So, while

it may be tempting to regard implant prosthodontics as a virtual panacea, it must be kept in mind that implant use can be far from straightforward or guaranteed to be problem-free. Routine implant treatment should not be promoted as a different and exclusive treatment modality; it remains one side of the same coin of our profession's treatment currency.

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