OSSEOINTEGRATION-THE KEY TO SUCCESSFUL IMPLANT PLACEMENT: A REVIEW

ABSTRACT
Osseointegration is a defined as: “the formation of a direct interface between an implant and bone, without intervening soft tissue”. Osseointegrated implant is a type of implant defined as “an endosteal implant containing pores into which osteoblasts and supporting connective tissue can migrate.” Applied to oral implantology, this thus refers to bone grown right up to the implant surface without interposed soft tissue layer. No scar tissue, cartilage or ligament fibers are present between the bone and implant surface. The direct contact of bone and implant surface can be verified microscopically.

Dental implants are by far the main field of application, Retention of a craniofacial prosthesis such as an artificial ear (ear prosthesis), eye (orbital prosthesis), or nose (nose prosthesis), Bone anchored hearing conduction amplification (Bone Anchored Hearing Aid).

This article reviews how Osseointegration has enhanced the science of medical bone and joint replacement techniques.

INTRODUCTION
Per-Ingvar Brånemark introduced the concept of osseointegrated dental implants and raised the bar for management of dental and orofacial deficits. As a result, long-term clinical outcomes from the technique’s scrupulously applied surgical and prosthodontic protocols ushered in a new and exciting dental treatment era, particularly for partially and completely edentulous patients.

Subsequent routine dental use of osseointegration resulted from a long research voyage in a vessel made seaworthy by the synergistic efforts of numerous clinical scientists.

The loosening of implants from bone tissues has been a cause of problems in reconstructive surgery and joint replacement. The thought for decades has been that the layer of fibrous tissue that develops around the implant diminishes the integrity and mechanical stability of the implant/bone interface.

In this brief review article we will attempt to highlight key developments in the research and application of osseointegration. Over the years, the concept of osseointegration has developed into as much of a philosophy as it is a technique for rehabilitation.

DISCUSSION
The patient has always been the focus of advances in the technique of osseointegration, and these advances have been the result of unprecedented levels of collaboration between health care providers, the research community, and the medical industry. The proceedings of the recent research conference in this area, Osseointegration. From Molecule to Man, documents the strength of the key components of science and health that have contributed to the success and growth of osseointegration. It also documents the value of an interdisciplinary and multidisciplinary approach to rehabilitation patient care that encompasses many fields of research and clinical endeavor.

Definition of Osseointegration
Osseointegration was originally defined as a direct structural and functional connection between ordered living bone and the surface of a load-carrying implant. It is now said that an implant is regarded as osseointegrated when there is no progressive relative movement between the implant and the bone with which it has direct contact. In practice, this means that in osseointegration there is an anchorage mechanism whereby nonvital components can be reliably and predictably incorporated into living bone and that this anchorage can persist under all normal conditions of loading.

Experimental Studies
The initial observations of osseointegration were made in the 1950s during the study of the circulation in bone marrow. In a modification of the rabbit ear chamber, a titanium implant with a central canal and a transverse opening at one level was threaded into bone to allow bone and vessels to grow into the chamber. It occurred to this investigator that such integration of titanium screws and bone might be useful for supporting dental prostheses on a long-term basis. Thus began a continuing program of research and clinical use of titanium implants.

Study of the biomechanics of osseointegration was a key early research activity, which was overseen by Professor Richard Skalak. Detailed biomechanical tests were performed by R. Brånemark and coworkers to evaluate implants during healing, after irradiation, in experimental arthritis, in osteoarthritis and rheumatoid arthritis, and in vivo in rat, rabbit, dog, and man. This series of studies provided evidence that the biomechanics of bone-anchored implants are complex. There was a plastic deformation of the bone-implant interface subjected to shear, and no elastic deformation was observed. In pullout and lateral load tests the load-
multicenter studies. Worldwide, more than 800,000 patients have been
segment of the mouth, and for the reconstruction of the completely
osseointegration has been the dental and oral reconstruction of patients

Dental

clinical applications is as follows:

As a biological phenomenon it has been amply demonstrated and

prostheses. These tests suggest that direct stable and permanent

This was different from the corresponding measurements obtained with a

spontaneous formation at atmospheric conditions. More extensive oxide
deposition occurs on titanium implants subjected to biological tissues (2).

Inflammatory cells, especially macrophages, may contribute to
development of the oxide layer by excreting proteolytic enzymes,
cytokines, superoxide, and hydrogen peroxide (3). It is hypothesized that
the actual interface of the titanium implant to the living tissue is a
hydrated titanium peroxy matrix. The formation of such a matrix is
unique to titanium, as other possible transition metals either have too
low solubility of their peroxy complex or too low stability of the complex.

Osseoperception

Osseoperception is the term used to describe the ability by patients
with osseointegrated fixtures to identify tactile thresholds transmitted
through their prostheses.

The oxide of titanium is covered with a very thin layer of titanium
peroxy compounds, which are in contact with the living bone. It is a
phenomenon of importance in both dental and orthopaedic applications
of osseointegration. The identification of osseoperception as a

phenomenon of osseointegration was the result of work carried out in the
dental sciences by Torgny Haraldson. In 1979 he characterized the

sensory feedback in patients with osseointegrated bridges and concluded,
" Patients with osseointegrated bridges have been restored to a level of

functional capacity of the maxillectomy equal to that in individuals
with a natural but reduced dentition of the same extension as in the

osseointegration group." Osseoperception has also been studied in
orthopaedic applications. Experimentally, vibratory perception around
implants in the femoral, tibial, ulnar, radial, and (meta)carpal bones has
been assessed by means of the psychophysical threshold determination of
passive stimuli applied to the implants, whereby the subject has to answer
whether he/she detects the stimulus or not (figure 1).

Experiments were carried out on two groups of patients who had

undergone amputation of their limbs. This method was also applied for threshold
determination of the stump of amputees in Group 2 to compare these

values to implant stimulation threshold. The measured perception of
vibration with an osseointegrated amputation prosthesis in place was
generally comparable to that of the normal contralateral hand or foot.

This was different from the corresponding measurements obtained with a

conventional amputation prosthesis. This finding has recently been
repeated in a series of 32 patients, and it was further documented that
boneanchored prostheses yielded better perception than socket
prostheses. Tests suggest that direct stable and permanent
anchorage of amputation prostheses to the skeleton via osseointegrated
fixtures, skin-penetrating abutments will be a useful clinical technique that improves an amputees perception of the environment.

Osseoperception is its use in providing for hearing prostheses.

ESTABLISHED CLINICAL APPLICATIONS OF

OSSEointegration

Osseointegration provides an attachment mechanism for the
incorporation into living bone of non-vital components made of titanium.

As a biological phenomenon it has been amply demonstrated and
clinically tested, and is now widely accepted. The present range of
clinical applications is as follows:

Dental

In the field of oral surgery, the most common application of
osseointegration has been the dental and oral reconstruction of patients
who have lost teeth. The anatomical and functional rehabilitation after
the loss of teeth implies replacement of the teeth and part of the
surrounding tissues because the loss of teeth results in involution of
periodontal tissues. Osseointegration has been used for the replacement
of missing single teeth, for the restoration of the partially edentulous
segment of the mouth, and for the reconstruction of the completely
edentulous patient by means of implant-supported fixed bridges or
removable overdentures that attach to an implant-supported framework.

The superior performance of osseointegration in dental applications
by comparison with other techniques has been confirmed in a number of
multicenter studies. Worldwide, more than 800,000 patients have been
examined since 1965 until now with osseointegration dental reconstructions
leading to Bränemark. The results indicate a clear superiority over conventional prosthodontics with respect to long-term

success rates (4,5). It should be pointed out that osseointegration in
dental sciences has been the subject of more than 2,000 scientific articles,
thus creating a solid research and clinical basis for this treatment
modality. Continued development and adaptation of surgical and
prosthetic procedures has allowed rehabilitation even of patients with
extensive loss of alveolar jawbone, including discontinuities of the jaw
skeleton, whether congenital, posttraumatic, or after tumor surgery.

Autologous bone grafts have proven beneficial in many of these
situations in combination with bone-anchored devices. Requirements on
precise fitting of prosthetic superstructures exceed those for devices
anchored to teeth, since the osseointegrated fixtures do not adapt to a
maladjusted prosthetic framework by changing their position in the
jawbone. This, on the other hand, means that fixtures can be used in
orthodontic procedures.

There has been a rapid development in orthodontic applications of
dental implants to provide anchorage for orthodontic, orthopaedic, and
orthognathic movements. One recent young patient with extensive
oligodontia has undertaken a program of several steps (6). The initial step
was the replacement of the missing mandibular dentition anterior to the
molar teeth by implant-anchored bridge work. Subsequently, implants
were placed to close the gaps, and subsequently, a fixed bridge was
used to provide maxillary molar support. A similar approach has
also been used for the replacement of a missing canine.

There have been a number of reports on the use of implants in
the maxilla to provide anchorage for orthodontic treatment of
the maxillary arch (7). In a recent report on the use of implants in
the maxilla to provide anchorage for orthodontic treatment of
orthognathic movements, a number of cases have been reported
in which implants were used to provide anchorage for orthodontic, orthopaedic, and
orthognathic movements. One recent young patient with extensive
oligodontia has undertaken a program of several steps (6). The initial step
was the replacement of the missing mandibular dentition anterior to the
molar teeth by implant-anchored bridge work. Subsequently, implants
were placed to close the gaps, and subsequently, a fixed bridge was
used to provide maxillary molar support. A similar approach has
also been used for the replacement of a missing canine.

CONCLUSION

Dental implants are truly a revolution, solving an age old problem safely
and predictably by successful osseointegration (figure 3). Implant
dentistry can change the smiles and lives of millions for years to
come. Dental implants are an effective, safe and predictable solution to the
problems resulting from missing teeth. Many patients report exciting
benefits from dental implants, such as:

Replacement teeth look, feel and function like natural teeth

Improved taste and appetite

Improved cosmetic appearance

The ability to chew without pain or gum irritation

Improved quality of life

One additional and very important benefit can be the reduction or
elimination of bone atrophy or shrinkage, commonly associated with
loss of teeth.
REFERENCES


