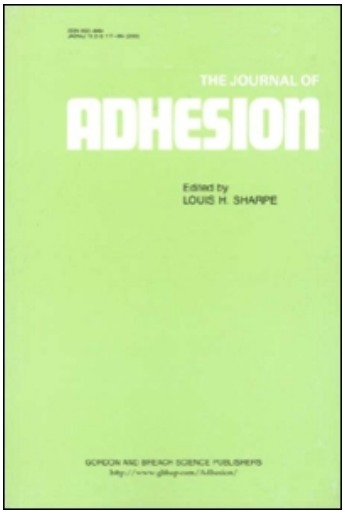

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Letter to the Editor

Robert Baier[a]; Per-Olof Glantz[b]
[a] Research Center for Biosurfaces, Hall Buffalo, NY, USA [b] School of Dentistry, Malmö, Sweden

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Letter to the Editor

RE: OSSEOINTEGRATION IN ORTHOPAEDICS

Dear Sir,

Recently (September 22–23, 1995) a small group (the undersigned) gathered in London for a workshop on Molecular and Cellular Biology of Osseointegration. Most of the discussion was quite technical, devoted to the molecular scale of adhesion of bone tissue to titanium implants, and will be reported in the technical literature in full in due time. In the course of the discussions it became obvious that numerous osseointegration possibilities exist in orthopaedics that may not yet be appreciated by the orthopaedics community, particularly in relation to the broader picture of successful dental applications of osseointegration. We therefore offer this letter remarking on the current scene.

Osseointegration is now an accepted concept and Dorland's Illustrated Medical Dictionary provides this definition: "*direct anchorage of an implant by the formation of bony tissue around the implant without the growth of fibrous tissue at the bone-implant interface*". By far the most extensive application of osseointegration to date has been in the field of dental implants for which the term was initially coined. Various forms of dental implants are now on the market, the original version being titanium screws-fixtures-which are implanted into carefully drilled and tapped holes of the mandible or maxilla and then left to integrate for 3 to 6 months. After this healing period, the screws are exposed and a prosthetic appliance, generally a bridge, is mounted on the fixtures which have a close apposition to bone (osseointegration) with a very high success rate (>95%). There are now approximately 400,000 patients worldwide wearing some 1,500,000 fixtures.

Meanwhile, in the orthopaedics and soft tissue research and clinical worlds, it appears that a consensus at this time would be that any implanted material regardlesss of its type (metallic, ceramic, polymer, etc.) will become surrounded by a soft fibrous tissue and cannot provide a long-term support or stability. However, the record in density of osseointegrated implants contradicts this consensus opinion. With very strict protocols for sterilization and scrupulous maintenance of cleanliness, careful surgery and subsequent healing period without load, the success rate of osseointegration in the dental application is routinely very high and very reliable. Futhermore, osseointegrated dental implants are stable under load without any time limit yet observed after 3 decades of continous use. It would appear that the widespread use and high clinical success rate of osseointegrated dental implants represents a situation in which the experiences from the dental field lead the way and should be used to improve outcomes in possible applications in orthopaedics and other areas. The purpose of this document

is to highlight differences in current experiences and to encourage more rapid development of osseointegrated prostheses in the orthopaedics field.

This process of development of osseointegrated prostheses in orthopaedics is already underway. Many successful cementless hip joints are probably at least partially osseointegrated although they are not designed with this outcome particularly in mind. Rather they are adaptations of existing designs and could be redesigned to include new geometries that may be much more effective. Indeed, novel applications of the osseointegration principle have been made for the purposes of prosthetic finger joints. In this case, titanium screws are placed in the marrow space of the finger bones and an elastomatic joint is used to connect them. To date, over 200 patients have been successfully treated this way in Lund, Malmö and Göteborg, Sweden. Hearing aids and other extraoral prostheses have also been supported on osseointegrated implants in approximately 6,000 patients worldwide. There are also examples of successful transcutaneous osseointegrated implants as well.

The consensus of our workshop is that there are no apparent barriers to the application of the osseointegration principle to any part or any bone of the body. A striking and pioneering application which has succeeded is, for example, an osseointegrated prosthesis for the femur in an above-the-knee amputation. In pilot cases now numbering approximately two dozen, a large (1.5–2.0 cm diameter) threaded fixture is placed directly into the central marrow space of the femur. In this case, the prosthesis is transcutaneous which resembles to some extent the transmucosal situation in dental implants. It would appear that this approach offers extensive opportunities for improvements in prostheses for amputees, replacement joints, and in repair of defects, but these are being, at present, pursued and capitalized slowly.

The key to successful osseointegration applications is in the selection and surface preparation of the material which is used. So far, pure titanium has proved to be the most reliable. It has been well established that the surface develops an oxide layer which is more like ceramic than metal. The very strict avoidance of any surface contamination and very gentle surgical handling of tissues are additional keys to success. The workshop considered events at all levels of length scales and the important effects at each level of tissues, cells and molecules for understanding of mechanisms underlying successful osseointegration. The molecular behaviour of proteins, particularly glycoproteins, and also some saccharides adhering to titanium oxide appear to be key features determining early implant success, but much more research is needed to establish the molecular details, permissible loading conditions, and most effective designs. Nevertheless, it is clear that a vast opportunity to open up new applications is present and we hope this letter may stimulate further investigation and clinical application of the osseointegration principle!

Professor Robert Baier
Research Center for Biosurfaces
110 Parker Hall
Buffalo, NY 14214, USA

Professor Per-Olof Glantz
School of Dentistry
Carl Gustavs väg 34
214 21 Malmö, Sweden

Professor Dick Heinegård
Lund University
Dept of Cell and
Molecular Biology
Section for Connective
Tissue Biology
P O Box 94
221 00 Lund, Sweden

Professor Per-Ingvar Brånemark
The Institute for Applied
Biotechnology
Box 5411
402 29 Göteborg, Sweden

Dr Adrian Parsegian
Laboratory of Structural Biology
Div. of Computer Research and
Technology
National Institutes of Health
Building 12A, Room 2041
Bethesda, MD 20014, USA

Professor Ingemar Lundström
Linköping University
Dept of Physics and
Measurement Technology
581 83 Linköping, Sweden

Dr Rickard Brånemark
The Institute for Applied Biotechnology
Box 5411
402 29 Göteborg, Sweden

Professor Richard Skalak
Institute for Mechanics and Materials
Engineering Bldg Unit 1, Room 1603
University of California, San Diego
9500 Gilman Drive
La Jolla, CA 92091-0404, USA

Professor Dennis Osmond
McGill University
Dept of Anatomy and Cell Biology
Strathcona Anatomy and Dentistry
Building 3640 University Street
Montreal PQ H3A 2B2 Canada

Professor John Frangos
Dept of Bioengineering 0412
University of California, San Diego
La Jolla, CA 92091-0421, USA