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Osseointegration and related treatment modalities: Future perspectives, quality of life, and treatment simplification

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Dr Robert Gottlander

Dr Robert Gottlander, DMD, graduated from the School of Dentistry of the University of Gothenburg, Sweden. He followed a number of business program courses at Northwestern University in Chicago. Dr Gottlander has held several key management positions within Nobel Biocare since 1984. In 2002, he joined the executive management group as vice president of global marketing management. He was appointed executive vice president of marketing and products in June 2005. Currently, Dr Gottlander is the executive vice president of global key account management. In 2008, Dr Gottlander received the Achievement Award of the Greater New York Academy of Prosthodontics for his contributions to the dental industry.

Dr Daniel van Steenberghe

Dr Daniel van Steenberghe, MD, PhD. After 1 year in general surgery, Dr van Steenberghe began a specialization in oral and maxillofacial surgery and in periodontology. He applied osseointegrated implants since 1982 at the University Hospital in Leuven, Belgium, where he was professor ordinarius. His research, besides multicenter studies on implant survival, focused on osseoperception and biofilm formation. He was the first to report on the use of two implants to retain an overdenture. He developed a CT-based planning system for implants. Dr van Steenberghe founded the European Association for Osseointegration and served as its first president. He is an honorary citizen of the city of Aix-en-Provence, France; twice doctor honoris causa; and co-opted member of the Royal College of Surgeons in Ireland and of the German Academy of Sciences (Leopoldina). He is an honorary Fellow of the Pierre Fauchard Academy. He has peer-reviewed authored or coauthored some 300 full papers in peerreviewed journals. No less than 17 of his PhD or Masters students have become university professors. Since 2007, he is Professor Emeritus of the Faculty of Medicine at the Catholic University of Leuven.
Man has used organic and inorganic materials for more than 7,000 years. Only in the 20th century was mankind able to create its own materials, targeting different purposes and having properties sometimes superior to those fashioned by nature.

Osseointegration has opened a new era for mankind. For the first time, one can predictably anchor for many years a permucosal or percutaneous prosthesis to bone. It goes from thumbs to ears and from legs to noses, but by far the largest field of application is edentulism. In the coming centuries, archaeologists will coin their findings based on the presence of titanium fixtures as the “pre- and post-Brånemark era.”

Osseointegration, like many other major discoveries (penicillin, interferon, radiographs, etc), is due to serendipity. The word was coined in the 18th century by Horace Walpole, referring to the novel The Three Princes of Serendip. These princes, travelling through the island of Serendip (Sri Lanka), “were always making discoveries, by accidents and sagacity, of things which they were not in quest of.”

The word sagacity is often occulted when people use the term. As Shakespeare’s King Henry V said, “All things are ready if our minds be so.” Brånemark’s discovery was followed for years by the invention and creation of hardware and software to bring the principle to clinical applicability, first intraorally to anchor dental prostheses. From 1982 onward, P-I Brånemark and his clinical collaborators trained hundreds of clinicians in oral health care worldwide. These pioneering teams, consisting of surgeons, nurses, dentists, prosthodontists, and anaplastologists, all travelled to Gothenburg. They became part of a fast-growing worldwide network of clinical and scientific expertise. All of these characters continue to work with fellow beings, handle unsettled questions, and are thus in quest of a better understanding of why it works and why sometimes it does not.

Although osseointegration has inspired a steeply increasing number of congresses, symposia, associations, and consensus conferences in different fields of medicine, engineering, and material sciences, Nobel Biocare felt, as a market leader, that patient care would benefit from an independent special forum that would perpetuate the lifetime work of P-I Brånemark. Thus, the series of P-I Brånemark Scientific Symposia was initiated. Such a multidisciplinary encounter offers a rich scientific landscape that reveals nearly unlimited possibilities for the application of inorganic building blocks to solving current problems in health care.

Renowned academics, researchers, and clinicians are invited as speakers to exchange their synoptic views about ongoing forefront research and elaborate on future perspectives in front of a selected group of clinicians. This group of clinicians, purposely limited to some 200, but with very different backgrounds, were selected on the basis of their contributions to patient care, associations, and science, and their willingness to join at their own expense. The program buildup was delegated to a scientific committee. Selection of speakers was solely based on literature search, citation index, and originality. Thus, the present and future fora will always gather many new faces. The speakers, assembled at this first symposium, were among the best of the breed of academic physicians and scientists. The curriculum vitae of each is a treatise on personal achievement.

The gap between clinical results and the laboratory model can be a big hurdle. These proceedings therefore also discuss the required approaches to move basic scientists closer to results at the clinical level.

We are indebted to all those who have given so generously of their time and energies to make this First P-I Brånemark Scientific Symposium a landmark meeting and event. It brought together, during 2 ½ days, people from all over the world to face the problems of optimizing and simplifying patient treatment and enhancing interdisciplinary interaction.

Finally, we are all indebted—both those present and those who could not join us—to the never-abating devotion of P-I and Barbro Brånemark to patient care.

Robert Gottlander Daniel van Steenberghe
Executive Vice President Chairman
Nobel Biocare Scientific committee
Dr Brien Lang

Dr Brien Lang received his DDS (1961) and MS (1965) degrees from the University of Michigan. In 1965, he joined the University of Michigan faculty, and he served as chair of the School of Dentistry Department of Prosthodontics from 1987 to 1998. His publication record includes more than 71 journal articles and 10 chapters in textbooks. His main research interests have been in the area of complete denture prosthodontics. Dr Lang is a member of numerous professional organizations and is both member and past president of the Academy of Prosthodontics. He received the Jerome M. and Dorothy Schweitzer research award from the Greater New York Academy of Prosthodontics in 1994 and the Presidents Award (1995) and Daniel Gordon Award (1997) from the American College of Prosthodontics. Retired from active faculty status in 1998, Dr Lang is now Professor Emeritus at Michigan.

Dr Friedrich Neukam

Dr Neukam studied dentistry from 1970 to 1976 at Mainz University. From 1979 to 1984, he studied medicine at Hannover University. He was a trainee in oral and maxillofacial surgery and senior staff at the Department of Oral and Cranio-Maxillofacial Surgery at Hannover University Medical School. In 1990, he earned his PhD, and in 1994, he became an associate professor. Since 1995, he has been chairman and head of the Department of Oral and Cranio-Maxillofacial Surgery at Erlangen-Nuremberg University Dental School. Since September 2000, he has been a member of the EAO Board. He was acting EAO President from 2006 to 2008. Since 2001, he has been the editor-in-chief of Deutsche Zeitschrift für Mund-Kiefer-Gesichtschirurgie; since 2007, the editor-in-chief of Oral and Maxillofacial Surgery; and since October 2003, an editorial board member to the journal Oral Science International. His professional work is focused on cleft lip and palate, orthodontic surgery, tumor surgery, oral implants, and bone grafts in combination with implants.

Dr Peter Thomsen

Peter Thomsen, MD, PhD, is a professor of biomaterials in the Department of Biomaterials at the Institute for Clinical Sciences of Sahlgrenska Academy at the University of Gothenburg, Sweden. He started his training in cell biology with Professor P-I Brånemark and Professor L. E. Ericson in the Department of Anatomy (University of Gothenburg). After a 4-year fellowship with the Swedish Medical Research Council, he succeeded Professor Brånemark in 1994 as professor and chair of Biomaterials. He was visiting professor at the IRC in biomedical materials, became International Fellow of Biomaterials Science and Engineering, received the European Society for Biomaterials George Winter Award, and became the Scientific Leader of the Institute of Biomaterials Cell Therapy in Gothenburg in 2005. In 2007, he was appointed director of the BIO-MATCELL Vinn Excellence Center of Biomaterials and Cell Therapy, University of Gothenburg. He has published 160 articles, made 150 conference contributions, and holds 8 patents/patent applications. He has supervised 16 PhD students.
Dr Patrick J. Henry

Dr Henry graduated from the University of Western Australia (UWA) with First Class Honors (1960). From 1961 to 1963, he attended the prosthodontics graduate program at Indiana University. From 1980 to 1992, he was director of the graduate program in prosthodontics at UWA. In 1991, he became the inaugural Honorary Clinical Professor of Dentistry at UWA. He holds an honorary membership with the Argentine Society of Oral and Maxillofacial Surgery. He is the recipient of a Distinguished Lecturer Awards from the Greater New York Academy of Dentistry and American College of Prosthodontists. He also has honor awards from the Korean Academy of Prosthodontics, Academy of Periodontology, PRC, and Thailand Prosthodontic Society. He holds an honorary doctorate of dental science from UWA. He has presented 250 lecture courses and programs in the USA, Canada, Scandinavia, Europe, Southeast Asia, Japan, New Zealand, South Africa, and South America. He is an editorial board member of several journals, contributor to 7 textbooks, and author or coauthor of over 100 publications.

Dr Ragnar Adell

Dr Adell received his BDS/DDS from the University of Lund (1964) and his PhD from the University of Göteborg (1974). He received his specialty board/diploma in oral and maxillofacial surgery from the Swedish National Board of Health and Welfare (1980). During his 40-year career, Dr Adell was at the University of Göteborg for 22 years, 14 of which he served as associate professor of oral and maxillofacial surgery. He served at the Brånemark Clinic for 13 years and as visiting professor at the University of Iowa. He was appointed head, specialty education program director, and associate professor of the Oral and Maxillofacial Surgery Department at Örebro University Hospital (1989) and acting head of the Center for Head and Neck Oncology (2007). Dr Adell has 55 published papers and has presented at nearly 50 symposia. He is a Fellow of both the Swedish Dental Association and the Swedish Association of Oral and Maxillofacial Surgeons, and he was both the vice president (1997) and president-elect (1998) of the Swedish Association of Oral and Maxillofacial Surgeons.

Dr Mário Groisman

Dr Groisman graduated from the State University of Rio de Janeiro in 1981. One year later, he began his specialist training in periodontology at the same university. In 1984, he moved to Sweden to be involved in the Master of Dental Science program at Lund University, Malmo. After returning to Rio de Janeiro, he was appointed as head of the Periodontology Department at Nova Iguacu University. In 1990, he became one of the first-recognized Brazilian specialists in oral implantology. Dr Groisman has structured oral implantology specialist programs at three different universities and was associate professor of the master’s degree program in oral implantology at UNIGRANRIO University. In 2004, he was appointed Dean of Estácio de Sá Dental School. From the beginning of 2007, he returned to his professor activities in the Department of Oral Implantology at São Leopoldo Mandic University, Rio de Janeiro, Brazil. Dr Groisman has published and lectured extensively.

Dr Shohei Kasugai

Dr Shohei Kasugai received his DDS and PhD degrees from Tokyo Medical and Dental University (TMDU). He was a postdoctoral Fellow at the University of Toronto from 1989 to 1991. He worked as an educator and a researcher in the Department of Pharmacology at TMU for 20 years, focusing on therapeutic drug development for osteoporosis and bone response to dental implant materials. In 2000, he became a professor in the Department of Oral Implantology and Regenerative Dental Medicine and director of the Dental Implant Clinic at TMU. His research is focused on developing biocompatible implants and bone regeneration. He has received awards from the International Association for Dental Research, the Pharmaco-Kinetics Society, the Japanese Association for Oral Biology, and the Academy of Osseointegration. He is a board member of the Japanese Academy of Maxillofacial Implants, a committee member of the Japanese Society of Oral Implantology, and an active member of the AO and EAO.
Dr Peter Moy

Dr Moy received his dental degree from the University of Pittsburgh, completed his general practice residency at Queen’s Medical Center in Honolulu, Hawaii, and received his specialty certificate in oral and maxillofacial surgery from the University of California at Los Angeles (UCLA). His current focus is oral and maxillofacial surgery using osseointegrated dental implants to reconstruct severely atrophic ridges. He is currently on staff in the Oral and Maxillofacial Surgery and Hospital Dentistry Departments at UCLA. He was recently named director of implant dentistry and director of the Dental Implant Center at UCLA. Dr Moy has written numerous articles related to implant dentistry and osseointegration, focusing on bone grafting and augmentation of atrophic ridges. He has lectured nationally and internationally, most recently at the 15th Annual Scientific Meeting of the European Association for Osseointegration. Dr Moy is currently the president-elect of the Academy of Osseointegration.

Dr Massimo Simion

Dr Simion received his degree in medicine and surgery at the University of Milan in 1979 and his specialization in odontostomatology and dental prosthodontics at the University of Milan in 1982. He is a professor and chairman of the Department of Periodontology and Implant Restoration at the Dental School of the University of Milan. He was a member of the board of the European Association for Osseointegration (EAO) from 1998 to 2005, president of the EAO from 2001 to 2003, and immediate past-president in 2004 and 2005. He has been a member of the EAO Council since 2005, and he is founder of the Italian Society of Osseointegration. He is an active member and was vice president of the Italian Society of Periodontology (SidP) from 2003 to 2005. He is a referee for the *Journal of Clinical Periodontology*, *Journal of Periodontology*, and the *International Journal of Periodontics and Restorative Dentistry*. He has published several scientific papers and is an international lecturer on the topics of periodontology, osseointegration, and bone regeneration.

Dr Adriano Piattelli

Dr Adriano Piattelli received his MD from Catholic University Rome (1975) and his DDS from Rome University (1988). He began consulting for the National Health Service (Italy) in 1990, and in 1997, he was appointed professor of oral pathology and medicine and dean and director of studies and research at the Dental School of the University of Chieti, Italy. He is a member of the American Academy of Osseointegration (AO), the International Association for Dental Research (IADR), and the International Association of Oral Pathologists (IAOP). From 2003 to 2005, he served as president of the Italian Society of Osseointegration (SIO). Dr Piattelli served on the board of the *Journal of Oral Pathology and Medicine* (1993–1999) and currently serves on the board of *Clinical Implant Dentistry and Related Research* (2002–).

Dr Bernard Touati

Dr Touati is a doctor in dental surgery and doctor in dental sciences (DDS-MS). He is a visiting professor at Hadassah Faculty of Dental Medicine in Jerusalem. From 1976 to 1985, he was assistant professor of prosthodontics (Paris 5 University). Dr Touati is the past-president of the European Academy of Esthetic Dentistry and the founder/past-president of the French Society of Esthetic Dentistry. He is also a member of the American Academy of Restorative Dentistry and the American Academy of Esthetic Dentistry. He is the co-academic director of the Global Institute for Dental Education and the editor-in-chief of *Practical Procedures and Aesthetic Dentistry* (USA). Dr Touati is an international lecturer, author of numerous publications all over the world, including the bestselling textbook *Esthetic Dentistry and Ceramic Restorations* (Martin Dunitz) and the book *Integration of Digital Ceramic Restorations* (Montage Media), and coauthor of the books *The Art of the Smile* (Quintessence) and *The Art of Treatment Planning* (Quintessence). He has been awarded the Legion of Honor in France.
Dr Georg Watzek

Dr Watzek received his MD degree in 1970, his specialty board examination in dentistry (DDS) in 1973, a fellowship at Columbia University, New York, in 1976, and his specialty board examination in oral and maxillofacial surgery in 1979. He was appointed senior resident, and in 1982 became head of the Department of Oral Surgery at the Dental School of the University of Vienna. In 1983, he became president of the Austrian Society of Oral Surgery and Implantology. From 1989 to 1993, he was president of the Austrian Society of Dentists and Stomatologists, and in 1991, he was named honorary member of the Hungarian Society of Dentists and Stomatologists. Between 1994 and 1997, he was a visiting professor at the University of Pennsylvania, and in 1998, he was appointed head of the Dental School of the University of Vienna. In 2003, he was president of the European Association for Osseointegration (EAO), and in 2006, he became an associate editor of the *International Journal of Oral and Maxillofacial Implants* (IOMI). He is the editor of 8 textbooks and author of over 200 publications.

Dr George Zarb

Dr Zarb is a retired professor at the Faculty of Dentistry of the University of Toronto, following a 40-year academic career. His research was in the field of implant prosthodontics. He is the recipient of an honorary doctorate of science from the University of Gothenburg, Sweden; an honorary doctorate of laws from Dalhousie University, Canada; an honorary MD from his original alma mater, the University of Malta; an honorary doctorate of medicine from the University of Turin, Italy; and an honorary doctorate of science from the University of Montreal. He also received an honorary fellowship in the Royal College of Surgeons in Ireland, an honorary fellowship from the Royal College of Dental Surgeons of England, and an honorary doctorate of science from the University of Toronto (2009). Dr Zarb has received the Thaddeus Weclew Honorary Fellowship from the Academy of General Dentistry, the Elmer S. Best Award from the Pierre Fauchard Academy, and the Goldhaber Science Award from Harvard University. He received the Golden Medal from the American Prosthodontic Society. He is past-president of the International College of Prosthodontists.
Dr Edmond Bedrossian

Dr Bedrossian received his dental degree from the University of the Pacific and completed his oral and maxillofacial surgery training at Alameda Medical Center. He maintains a private practice in San Francisco, California. He maintains a dual appointment at the University of the Pacific as the director of implant surgical training for the oral and maxillofacial surgery residency training program and the director of postgraduate prosthetic implant training at the university’s AEGD residency training program. He has authored numerous articles and coauthored with Professor Brånemark a textbook chapter on the indications for the use of the zygomatic implant. He has lectured internationally on the topics of site preparation and the treatment planning and surgical management of patients with severely atrophied jaws or maxillofacial defects. He is a member of the board of directors for the Brånemark Institute and the current president of the Brånemark Foundation North America.

Dr Gordon William Blunn

Dr Blunn is a professor and center head of biomedical engineering at the Institute of Orthopaedics and Musculoskeletal Science, University College London, Royal National Orthopaedic Hospital, Brockley Hill, Stanmore, Middlesex, UK. He earned a BSc in marine biology (Joint Hons) from the University College of North Wales, Bangor, in 1978 and a PhD (Corrosion of Metal Alloys by Marine Biofilms) from the University of Leeds in 1982. He was a postdoctoral research associate at Portsmouth Polytechnic from 1982 to 1985, and he was director of Stanmore Implants Worldwide from 2000 to 2008. He was director of VetCell from 2004 to 2006, and he is currently the director of both Biomedica (2006–) and Orthofit (2008–). He has received the Business Award from the University College London, the NHS innovation award, and the BUPA award for the best innovation to improve child health.

Dr Barbara Boyan

Dr Boyan received her BA in biology and her MA and PhD in comparative biochemistry and physiology from Rice University in Houston, Texas. She has held many appointments, including: Postdoctoral Fellow of Calcification Mechanisms at the University of Texas Health Science Center at Houston; director of research at the University of Texas Health Department of Orthopaedics Science Center at San Antonio; adjunct professor at the University of Texas Health Department of Periodontics Science Center at San Antonio; adjunct professor at Emory University Medical School Departments of Orthopaedics and Cell Biology in Atlanta, Georgia; adjunct professor at the Georgia Institute of Technology School of Materials Science and Engineering in Atlanta, Georgia; Price Gilbert, Jr Chair in Tissue Engineering at the Georgia Institute of Technology; Georgia Research Alliance Eminent Scholar in Atlanta, Georgia; director of the Georgia Institute of Technology Children’s Healthcare of Atlanta Laboratory for Craniofacial Plastic Surgery Research; and associate dean for research at the Georgia Institute of Technology College of Engineering.

Dr John Brunski

Dr Brunski is a professor in the Department of Biomedical Engineering at Rensselaer Polytechnic Institute in Troy, New York, and a senior research engineer in the Division of Plastic and Reconstructive Surgery in the School of Medicine at Stanford University. For over 30 years, his research has focused on bioengineering aspects of dental implant design and the bone-implant interface. He has authored numerous papers and textbook chapters on oral implants and has given over 150 presentations on these subjects at national and international meetings. Dr Brunski serves as an associate editor of the International Journal of Oral and Maxillofacial Implants and is a member of the editorial board of Clinical Oral Implant Research. Dr Brunski serves on NIH’s Musculoskeletal Tissue Engineering Study Section and has received a number of awards for his research, including the 2007 Anders Tjellström Award and the 2008 Astra Tech Scientific Award for Applied Research in Osseointegration.
Dr Joel D. Bumgardner

Dr Joel D. Bumgardner is a biomaterials researcher with extensive experience and expertise in the dental alloys and dental implant and surface coatings. He is an associate professor in the Biomedical Engineering Department at the University of Memphis and holds joint appointments in the University of Tennessee Health Science Center. He has authored numerous papers and book chapters on the degradation, compatibility, and surface modification of dental alloys and implant materials. He obtained his BS degree in biology from Florida State University and his BS in materials science and MS and PhD in biomedical engineering all from the University of Alabama at Birmingham. He was a Fulbright Scholar at the Umeå University School of Dentistry in Sweden. His current research is focused on the bioactive degradable chitosan polymers and composites for implants, regenerative medicine, and military wound infection prevention applications.

Dr Bo Chen

Dr Chen is an assistant professor in the Department of Oral Implantology at the Peking University School of Stomatology. She received her DDS degree from Peking University School of Stomatology in 1993, continued with residence training in oral and maxillofacial surgery, and completed her doctor degree of medicine in 1998. Her main fields of interest include implant-related treatment, orthognathic surgery, and psychological aspects of patients in these fields.

Dr Ramesh Chowdhary

Dr Chowdhary is a prosthodontist specializing in implant-based treatments. He holds the position of clinical professor at HKE’s S Nijalingappa Institute of Dental Sciences and Research in Gulbarga, India. He is also the director of the Academy of Dental Implant Research (ADIR), a nonprofit association that operates a clinic focusing on the rehabilitation of patients with missing teeth and maxillofacial malformations resulting from accidents or illness. He has authored several papers on implant prosthodontics and related topics. He studied dentistry at the Government Dental College in Bangalore, India, and the masters program in prosthodontics from SDM College of Dental Sciences in Dharwad, India. He is presently pursuing his PhD research program in the Department of Odontologia at Malmö University in Sweden. He holds a T. C. White Visiting Scholar Award from the Royal College of Physicians and Surgeons in Glasgow, UK. His research focuses primarily on implant design and simplification of implant treatment modalities.

Dr Lyndon Cooper

Dr Cooper, DDS, PhD, is the Stallings Distinguished Professor of Dentistry of the Department of Prosthodontics at the University of North Carolina at Chapel Hill. He is currently chairperson, acting director of graduate prosthodontics, and the director of the Bone Biology and Implant Therapy Laboratory. Dr Cooper is a diplomate of the American Board of Prosthodontics and serves as the president-elect of the American College of Prosthodontics Board of Directors. He received the ACP’s 2004 Clinician/Researcher Award and the IADR’s 2009 Distinguished Scientist Award for Prosthodontics and Implantology. Dr Cooper’s laboratory focuses on bone biology, adult stem cell bone regeneration, and clinical evaluation of dental implant therapies. The laboratory receives funding through NIH and by industry collaboration. Their research findings have been presented in over 90 publications and in more than 200 national and international presentations. These efforts integrate basic and clinical research to improve patient care.
Dr Cor Cremers
Dr Cremers is a professor of otology at the Radboud University Nijmegen Medical Center. In The Netherlands in June 1988, he started the Baha program. The Baha system was soon recognized in The Netherlands as regular medical care. With the Nijmegen Baha team, he produced over 50 clinical, audiologic, and quality-of-life papers. He has widened the clinical indications for the Baha application and contributed to the FDA clearances for the Baha system. In 2004, he received the second Anders Tjellstrom Award. He pioneered in the startup of (semi-)implantable hearing-aid systems like the Vibrant Soundbridge and Otologics MET. For decades, he has been internationally well-known as a pioneer in the field of genetic hearing impairments. He has published over 450 scientific papers in international peer-reviewed journals. In 2009, he received a knighthood in the order of the Dutch Lion.

Dr Andrew Dawood
Dr Dawood is a registered specialist in periodontology and prosthodontics, working in private practice in London and also in the Department of Maxillofacial Surgery at St Bartholomew’s, the Royal London Hospital Trust, and the University College Hospital in London. He runs a unique, private, multidisciplinary specialist referral practice. The need for exemplary imaging and computer planning for complex oral implant treatments led to the development of cavendishimaging.com, an imaging and surgical planning facility that has operated as a freestanding entity for 15 years. Along with a team of scientists and 3D technologists, cavendishimaging.com provides imaging, computer planned surgical solutions, and rapid prototype models, guides, and craniofacial implants for implant and maxillofacial surgeons and hospital departments around the UK. He lectures extensively on topics related to oral implants, imaging, and surgical planning. He also operates a center for postgraduate education and hosts regular meetings and seminars from premises in London, Oxford, and Birmingham.

Dr Marco Esposito
Dr Esposito is senior lecturer in oral and maxillofacial surgery, editor of the Cochrane Oral Health Group, and director of the postgraduate dental specialties courses in dental implantology (certificate, diploma and master) at the School of Dentistry of the University of Manchester in the UK. He is associate professor in biomaterials with the Sahlgrenska Academy at Göteborg University in Sweden and editor-in-chief of the European Journal of Oral Implantology. Dr Esposito graduated with honors in dentistry at the University of Pavia, Italy, in 1990 and was awarded a PhD in biomaterials from the Göteborg University in 1999. He worked as guest researcher at NIOM (Scandinavian Institute of Dental Materials) in Haslum, Norway, and is a specialist in periodontology (UK). He has authored more than 120 scientific publications in international peer-reviewed journals. His main research interest is the assessment of the effectiveness of various therapeutic interventions with particular emphasis on oral implants.

Dr Marcelo Ferraz de Oliveira
Dr Ferraz de Oliveira specializes in maxillofacial prosthodontics and craniofacial reconstruction for patients with special needs. He is also a renowned lecturer and author. After attaining his DDS from the Faculty of Dentistry in Valença, Brazil, he completed his residency at the Hospital of Cleft Lip and Palate Research Rehabilitation in Bauru, Brazil. In his quest for excellence, he pursued a specialization in oral rehabilitation at the Hospital of Cleft Lip and Palate Research and Rehabilitation from the University of São Paulo in Bauru. In 1994, he went on to pursue a fellowship in maxillofacial prosthodontics at the University of Iowa Hospitals and Clinics in the United States. He has been the subject of a host of television interviews on the subjects of facial, foot, and hand prosthetics. Dr Ferraz de Oliveira has pursued numerous postgraduate residencies and attends international conferences regularly. He has authored several publications including Craniofacial Prostheses: Anaplastology and Osseointegration (Quintessence).
Dr Kenji W. Higuchi

Dr Higuchi was an early pioneer in the clinical application of osseointegration. He has held several faculty appointments at the University of Iowa in the Department of Oral and Maxillofacial Surgery. A close associate of Professor P-I Brånemark since 1982, Dr Higuchi has participated in nine multicenter clinical trials involving implant performance, bone graft augmentation, guided bone regeneration, and the use of rhBMP-2. An international lecturer and contributor to journals for over 25 years, Dr Higuchi serves on the review board for the *International Journal of Oral and Maxillofacial Implants* and *Clinical Implant Dentistry and Related Research*. His special interest in implant rehabilitation includes the comprehensive treatment of major defect anatomy. A diplomate of the American Board of Oral and Maxillofacial Surgery and a Fellow in the American College of Dentists, International College of Dentists, and the International Association of Orofacial Reconstruction, Dr Higuchi maintains a private practice in Spokane, Washington.

Dr Jeffrey Hollinger

Dr Hollinger has since 2000 been a tenured professor at Carnegie Mellon University (CMU) in the Departments of Biomedical Engineering and Biological Sciences and the director for the Bone Tissue Engineering Center at CMU. From 1993 to 2000, he was a tenured professor at the Oregon Health Sciences University in the Departments of Surgery and Developmental Biology and directed the Northwest Wound Healing Center. Dr Hollinger retired in 1993 from the United States Army as a colonel after serving 20 years of active duty. During that period, he was the director of the Army’s Bone Program as well as the director for the Departments of Physiology and Biochemistry at USAIDR. Dr Hollinger has over 30 years of experience in bone regeneration using biological factors, biomaterials, and preclinical animal models. He has received numerous funded grants on applied and fundamental biology for bone regeneration and is engaged with several industrial groups emphasizing bone regenerative therapeutics, in addition to serving on corporate boards. Dr Hollinger has several patents, has licensed technology developed in his lab, and helped bring a tissue engineering product containing recombinant human platelet-derived growth factor to the clinic and gain FDA clearance. In 2008, he received the prestigious Clemson Award in Biomaterials. Dr Hollinger has over 250 peer-reviewed publications, abstracts, book chapters, and books.

Dr Stefan Holst

Dr Holst received his doctorate in 2000 from the Medical University of Hannover with the title of Dr Med Dent. From 2000 to 2001, he attended a postgraduate program in the Department of Prosthodontics at Louisiana State University under G. Chiche. In 2001, he was appointed assistant professor of prosthodontics at the Dental Clinic 2 of the University Clinic in Erlangen, Germany, under M. Wichmann. In 2006, Dr Holst completed his habilitation thesis, receiving his Dr Med Dent Habil (PhD equivalent) degree from the University of Erlangen-Nuremberg. Dr Holst specializes in esthetic dentistry with an emphasis on implants, perio-prosthetics, and complex interdisciplinary treatments. His research focuses primarily on CAD/CAM technology/digital dentistry and related material sciences, as well as all ceramic restorations. In 2006, Dr Holst was appointed clinical associate professor and senior lecturer at the Dental Clinic 2, and in 2009, he became associate editor of the journal *Quintessence International*.

Dr Reinhilde Jacobs

Dr Jacobs is a dentist, doctor of dental sciences, periodontologist (KU Leuven) and master in dental radiology (University of London). She is head of the oral imaging center as full professor at the Dental Clinic 2 of the University Clinic in Erlangen, Germany, under M. Wichmann. Since 1990, her research has focused on oral implant physiology, with osseoperception studied in collaboration with Professor P-I Brånemark (Institute for Applied Biotechnology) and Professor B. Rydevik (Göteborg University) via an EC fellowship (1994–1995). Dr Jacobs is European director of the International Association of DentoMaxilloFacial Radiology and president-elect of the European Academy of DentoMaxilloFacial Radiology. She is an associate editor of *Clinical Oral Investigations* and the *Journal of Oral Rehabilitation* and author or coauthor of 5 books and 130 peer-reviewed publications.
Dr Torsten Jemt

Dr Jemt was a coworker of Professor P-I Brånemark. While at that position, he was responsible for the development of the first single-implant abutments. He has published over 120 scientific publications and is an internationally renowned speaker. He graduated with his DDS (1975) in Gothenburg, Sweden, was board certified as a specialist in prosthodontics in 1982, and attained his PhD in 1984. He became an associate professor in 1986 and later served as professor in the Department of Prosthetic Dentistry and Dental Materials at the Sahlgrenska Academy at Göteborg University. Professor Jemt cofounded the Brånemark Clinic in 1986, an implant specialty clinic in Gothenburg. He has served as chairman of the Brånemark Clinic since 2000. Professor Jemt is a member of the editorial boards of the International Journal of Prosthodontics and Clinical Implant Dentistry and Related Research. He continues to lecture throughout the world.

Dr Bengt Kasemo

Dr Kasemo has been a professor of physics at Chalmers University of Technology in Gothenburg since 1983. He has published over 400 scientific papers and has been cited around 12,000 times. He is active in the fields of surface science, nanoscience and nanotechnology, biomedical materials, catalysis and sustainable energy technology, with surface and interface phenomena as a common denominator. He is a member of the Royal Swedish Academy of Sciences and Royal Swedish Academy of Engineering Sciences (IVA). He has received several awards including the Gold Medal Large Size from IVA (2007), the George Winter award from the ESB (1999), and the Akzo-Nobel Prize from IVA (2001). He has about 15 patents and has cofounded four start-up companies, of which one, Q-Sense AB, is still active. He is a member of the international selection committee of the international Millennium Technology Prize and on many scientific advisory boards: the Fritz Haber Institute in Berlin, the Hefei National Laboratory for Physical Sciences at the Microscale (HFNL) of the Chinese Academy of Sciences, and the Center for Individual Nanoparticle Functionality (CINF) at DTU Copenhagen.

Dr Anil Kohli

Dr Anil Kohli has received the highest recognition for his contribution to the dental profession in India, being awarded the Padma Shri and Padma Vibhushan by the president of India. He is currently elected for his second tenure as the president of the Dental Council of India. He also has an honorary rank of brigadier and is a consultant to the Indian Armed Forces. He received the Fellowship of the Royal College of Dental Surgeons in 2007, and he is the chairman for the commission on education for Asia Pacific and Commonwealth countries. A master Fellow of the International College of dentists, he is a diplomat of the International College of Implantologists. He serves on the boards of various universities and academic bodies and maintains a leading practice in Delhi.

Dr Ye Lin

Dr Lin is a professor and chairman of the Department of Oral Implantology and vice-dean of the School of Stomatology at Peking University. His professional fields include orthognathic surgery, oral implantology, and maxillofacial traumatology. He is president of the Chinese Association of Oral Implantology and vice president of the Asia Oral Implant Academy Education. From 1978 to 1998, he was a student at the Xi’an Medical University. In 1986, he completed his postgraduate training at West China University of Medical Sciences (WCUMS). From 1986 to 1990, he was chief resident and lecturer in the Department of Oral and Maxillofacial Surgery at WCUMS. From 1990 to 1995, he was a resident doctor in the Department of Oral and Maxillofacial Surgery at the University of Cologne in Germany. And since 1995, he has been a professor in the School of Stomatology at Peking University.
Dr Göran Lundborg

Dr Lundborg studied medicine and received surgical training in orthopedics and plastic surgery at Sahlgrenska Hospital of the University of Göteborg. From 1983 to 1987, he was head of the hand section at Lund University in the Department of Orthopedics. Since 1988, he has been a professor of hand surgery at Malmö University Hospital in Sweden. He began his scientific training with P-I Brånemark at Göteborg University in 1963. His dissertation, addressing microcirculation in nerves (Ischemic Nerve Injury) was presented in 1970. His current research interests include nerve reconstruction, brain plasticity, joint implants, and mind-controlled artificial hands.

Dr Stefan Lundgren

Dr Lundgren received his degree in dentistry in 1977 at the University of Umeå. He entered residency in oral and maxillofacial surgery and a PhD program at the University of Umeå in 1980, and he completed his doctoral dissertation in 1985. He became a board-certified specialist in oral and maxillofacial surgery in 1988. From 1989 to 1990, he held a position as surgical Fellow at the UCLA Medical Center. In 1994, he became a professor of the Department of Oral and Maxillofacial Surgery at Umeå University, and in 1999, he was appointed chairman of the same department. He is the head of an international research group that focuses on reconstruction of hard and soft tissue in conjunction with implant surgery. This research has resulted in more than 40 original publications, review articles, and book chapters during the last 10 years. Dr Lundgren is a board member of the International Academy for Oral and Facial Rehabilitation and the Strasbourg Osteosynthesis Research Group, and he is an editorial board member of the International Journal of Oral and Maxillofacial Surgery and Clinical Implant Dentistry and Related Research.

Dr Birte Melsen

Dr Melsen received her DDS in 1964 from the Royal Dental College in Aarhus, Denmark, and became a professor in 1975 in the college’s Department of Orthodontics. She is the former president of the Danish, Scandinavian, and Nordic Orthodontic Societies, former president of the 3rd International Symposium on Feeding and Dentofacial Development, and former president of the European Orthodontic Society. She has been awarded the World Prize in Orthodontics from SIDO, and she has been knighted by the Queen Margrethe 2nd Knight of Dannebrog, 1st degree. Dr Melsen holds an honorary doctorate degree from the Sociedade Paulista de Ortopodntia, and she has honorary memberships in 12 orthodontic societies. She is the recipient of many other national and international awards. Dr Melsen is the editor of 3 textbooks and coeditor of the journal Clinical Orthodontics and Research, the Journal of Clinical Orthodontics, and the World Journal of Orthodontics. She has more than 330 publications in international refereed journals.

Dr Ramón Martínez Corriá

Dr Ramón Martínez Corriá, MD, DMD, is an oral and maxillofacial surgeon. He is the director of the Brånemark Osseointegration Center in Madrid, Spain, and a research member at the Embryology Institute of the Complutense University in Madrid. Since 1985, he has maintained a private practice that is dedicated exclusively to implant surgery and bone regeneration.
Dr Takashi Miyazaki

Dr Takashi Miyazaki has served as the dean of the Showa University School of Dentistry since 2003. He has also served as professor and chairman of the Department of Oral Biomaterials and Technology since 1993. Dr Miyazaki earned both his DDS and PhD from the Tokyo Medical and Dental University. His primary research interest is the application of new biomaterials and technologies to clinical dentistry. He invented the IAT implant system™ (wire-type electric discharged machined titanium implants) in 1995. He has also been involved in the development of dental CAD/CAM systems and developed the Decsy system™ in 1999. Dr Miyazaki is a member of the International Association for Dental Research, a Fellow of the Academy of Dental Materials, former president of the Japanese Society of Dental Materials and Devices, and president of the Society of Titanium in Dentistry.

Dr Ulf Nannmark

Ulf Nannmark earned his DDS in 1987 and his PhD in 1992. From 1989 to 1993, he was an assistant professor in the Brånemark Clinic in Gothenburg, Sweden; from 1993 to 1995, he was a research associate at the University of Göteborg; and from 1995 to 1998, he was a research associate professor at the University of Aarhus in Denmark. He was a visiting professor at the SouthWest Cancer Center in Leiden, The Netherlands, in 1996 and an associate professor in the Brånemark Center in Gothenburg from 1998 to 2004. He is the manager of EBM (2005–), and he has maintained a private clinic since 2005. His ongoing clinical and preclinical research with UNIFESP Brazil focuses on strategies in maxillofacial rehabilitation after tumor resection, irradiation and chemotherapy, gene expression by real-time qPCR in bone and soft tissue, and bone regeneration. He received the A. J. Herman Fellowship Award from the University of Western Australia in 2006. Dr Nannmark is the scientific advisor to Sopherion Therapeutics, and he is on the editorial board of Clinical Implant Dentistry and Related Research. He is also an ad hoc reviewer for Infection and Immunity, the International Journal of Cancer, Clinical and Experimental Metastasis, Cancer Research, FEBS Letters, and the Journal of Periodontology. He has published over 85 publications and over 200 abstracts.

Dr Liene Molly

Liene Molly graduated as a periodontologist from the Catholic University of Leuven, Belgium, in 2001. Her PhD focused on immediate loading of oral implants. Together with her mentor, Professor van Steenberghe, she helped develop and improve the guided surgery procedure called Litorim. From 2006 to 2008, she was a professor in the Department of Periodontology at the University of Maryland in Baltimore, where she was heavily involved in the undergraduate implant program and research projects in different fields. She maintains a private practice in periodontology and oral surgery in Roermond, The Netherlands. She is an external examiner at Barts and the London School of Medicine and Dentistry. She is reviewer for the Journal of Oral Rehabilitation, TripleO, and the Journal of Periodontology. She has published multiple peer-reviewed articles and book chapters and lectured in countries all over the globe.

Dr Gerry M. Raghoobar

Gerry M. Raghoobar received his DDS and MD degrees at the University of Groningen. In 1988, he qualified as an oral and maxillofacial surgeon and became a staff member in the University Medical Center Groningen with a focus in implantology and reconstructive preprosthetic surgery. He defended his PhD thesis in 1991 at the University of Groningen. He is a professor in the Oral and Maxillofacial Implants Department at this university. He is a Fellow of the European Board of Oral and Maxillofacial Surgery. His current research efforts are focused on oral and maxillofacial implantology, bone augmentation techniques, reconstruction of bone defects, and distraction osteogenesis. He has published over 150 papers in refereed journals and contributed to several book chapters.
Dr Zhijian Shen

Dr Zhijian Shen is an expert in ceramics science and engineering, specializing in the design and synthesis of advanced ceramics and composites with tailored microstructures and chemistry for structural and functional applications. He holds a position as a professor (Nobel Biocare Chair of Materials Innovation) at Arrhenius Laboratory at Stockholm University, where he also serves as an area manager of Biomaterials in the Berzelii Center EXSELENT on Porous Materials, strategically supported by the Swedish Governmental Agencies VR and VINNOVA. He has authored more than 200 published papers on ceramics and ceramic processes. He was educated in China; received his PhD on materials, physics, and chemistry in 1990; and was appointed as an associate professor in 1992 at Zhejiang University. In 1993, he moved to Sweden, initially as a postdoctoral researcher, and later he was appointed as a senior researcher, associate professor, and professor in the same institution.

Dr Björn Söderfeldt

Dr Söderfeldt is a professor of oral public health in the Faculty of Odontology at Malmö University in Sweden. There is only one such department in Sweden. He has a background in political science at the University of Uppsala and also in public health at Karolinska Institute in Stockholm. His chief research domains include oral health care, quality of life, assessment of patient satisfaction, and oral disease epidemiology, together with the organization of oral health care and its psychosocial work environment. He has published about 250 scientific papers.

Dr Gerlig Widmann

Dr Gerlig Widmann is an expert in 3D-navigation and computer-assisted implant surgery. He holds a position as resident at the Department of Radiology at the Medical University of Innsbruck, where his clinical focus is currently in the field of head and neck radiology and interventional radiology. He has authored several published papers on computer-assisted implant surgery and various related topics. He studied dentistry and human medicine at the Medical University of Innsbruck and obtained his doctorate in human medicine in 2004 (doctoral thesis on computer-assisted planning in oral implant surgery with summa cum laude). He started his residency in radiology at the Medical University of Innsbruck in 2005, where he joined the first group worldwide using 3D-navigation technology for percutaneous tumor ablation and interventional pain management. His research is focused primarily on 3D-navigated interventional radiology and computer-assisted implant surgery.

Dr Ulf M. E. Wikesjö

Dr Ulf M. E. Wikesjö received his DDS from Lund University in Sweden and a DMD from Temple University in Philadelphia. He was certified for advanced training in periodontology from the National Board of Health and Welfare in Sweden and from Loma Linda University in California, and he completed his PhD/Odont Dr on experimental wound healing from Lund University. Dr Wikesjö holds appointments as professor of periodontology, oral biology, and graduate studies; associate dean of research; and director of the Laboratory for Applied Periodontal and Craniofacial Regeneration at the Medical College of Georgia in Augusta, Georgia. He is a diplomate of the American Board of Periodontology. He serves on the editorial board of several scientific journals in periodontology and implant dentistry. He is the author of more than 190 original articles, reviews, and chapters and 150 abstracts in refereed scientific journals and texts, and he has made more than 200 invited presentations at international scientific workshops and conferences, academic institutions, and to learned societies.
Opening Remarks
(Moderator: George Zarb)

George Zarb started the session by referring to the celebration of Charles Darwin's 100th birthday.

Richard Dawkins, the brilliant author of *The Selfish Gene* and *The Blind Watchmaker*, recently observed that Darwin’s great idea has moved on, and that if the latter returned to see 21st-century evolutionary science, it would both enthrall and amaze him. But he would not recognize it as his own, since modern scientists are coloring in amazing and exciting details. I suspect that Per-Ingvar Brånemark regards the evolution of his own eclectic research contributions in a similar context, while the rest of us go on regarding his seminal publication as deserving of a new category of a world heritage site.

He then introduced the first two speakers of the symposium with these welcoming words:

The first, Per-Ingvar Brånemark, discovered and developed osseointegration in all its applications in different medical fields. The second was the prime mover in the genesis of this symposium and representative of the collective of grateful and admiring disciples of the former.
Per-Ingvar Brånemark: Simplification, a Patient-Orientated Approach

Mr Chairman, integrated friends and colleagues, I am sincerely appreciative of the fact that so many of the good old pioneers have come here to assist in understanding how is it possible to optimize and make safe and simple the treatment of patients.

What is osseointegration? It’s something that we learned the hard way. But we listened to the signs of Mother Nature and we learned that it is not carpentry but rather something that relies on bone marrow, stem cells, and blood. We learned, quite unbelievably, that there was a connection between the osseointegrated titanium element and the brain, so that osseointegration and osseoperception become a functional unit. Even if we cannot fully replace what was formed from the beginning, we can possibly improve the quality of life for those patients who have lost a finger, a tooth, a leg, or an ear.

We can exemplify the early clinical applications by a 50-year-old man (Fig 1) who got some fixtures in his upper jaw on top of which a fairly simple prosthetic device was fixed. The abutment device fractured after some years and the fixture had to be removed. It had to be cut out and the histologist made this electron microscopic picture. It indicates the intimate relationship between the titanium oxide layer and the bone substrate. We are nowadays going all the way down below the atomic level and the genetic code to the molecular condition of the growing tissue.

The first approach on human microcirculation by vital microscopy was performed on 17 volunteering and dedicated medical students. This is how we got some ideas of the possibility to apply this in clinical reality. The intracapillary blood cells told us that there is a limit of resistance to the brutal assault that we, in the clinical reality, apply on the microcirculation. We also found later on that the critical temperature to induce irreversible cell death can be as low as 42°C for the bone tissue when maintained for 1 minute. This is something to remember when you move around in an operating room, where you can smell the presence of sawed bone. In the late 1950s we also installed a microscopic lens system encased in titanium into the fibula to be able to follow the microcirculation in vivo for many weeks and months.

When this microscopic device could not be unscrewed from the bone into which it had been inserted but had to be broken out, the basis was laid for applications of prosthetic de-
VICES ANCHORED TO THE BONE IN ALL PARTS OF THE HUMAN BODY, PARTICULARLY IN THE ORAL CAVITY. IN THE CRANO FACIAL REGION, THE MASTOID REGION FOR HEARING DEVICES BECAME A MAJOR FOCUS.

WHEN WE FOLLOWED THE HEALING OF BONE AFTER INSERTING A PIECE OF TITANIUM, WE ALSO CONSIDERED TIME. IT WAS SUGGESTED AND PROVEN THAT, ALTHOUGH A TWO-STAGE PROCEDURE WAS SAFE, IT MIGHT BE POSSIBLE TO DO IT IN ONE STAGE AND EVEN ALLOW IMMEDIATE LOADING.

WE SHOULD REMEMBER THERE ARE MILLIONS OF EDENTULOUS PERSONS IN CHINA, IN INDIA, IN BRAZIL, WHO ARE IN NEED OF A FIXED ANCHORAGE FOR THEIR DENTAL PROSTHESIS. IS IT POSSIBLE TO USE IN THESE COUNTRIES HIGH-END CLINICAL PROCEDURES? WHY NOT? BUT WE NEED LONG-TERM FOLLOW-UP. AND IT IS NOT NECESSARY THAT WE SHOULD USE ONE STANDARD PROCEDURE FOR EVERY PATIENT OR FOR EVERY CLINIC IN DIFFERENT PARTS OF THE WORLD. WE SHOULD BE OPEN-MINDED.

THE ITEMS TO CONSIDER AT THIS SCIENTIFIC SYMPOSIUM ARE THE CRITICAL DOCUMENTATION OF LONG-TERM RESULTS: SUCCESS, COMPLICATIONS, FAILURES, QUALITY OF LIFE... WE MUST TRY TO AGREE ON THE LIMITS OF WHAT ONE CAN DO WITH VERY SOPHISTICATED METHODS. HIPPOCRATES SAID, "YOU PUT YOUR HAND ON THE PATIENT AND SAY I’LL DO MY BEST." ALL RIGHT, THAT’S GOOD ENOUGH, BUT THEN WE SHOULD SHARE INFORMATION ON SUCCESS, COMPLICATIONS, AND FAILURES OVER THE LIFETIME OF THE PATIENT.

THIS IS THE FIRST PATIENT WE TREATED IN 1965 (FIGS 2 AND 3). BEFORE GOING FOR CLINICAL APPLICATIONS, WE HAD REMOVED TEETH IN HUNTING DOGS AND PUT IN TITANIUM ANCHORAGE FOR WELL CUTTING TEETH. AFTER 10 YEARS OF REASSURING ANIMAL DATA, WE DECIDED TO GO FOR A VERY PARTICULAR PATIENT. HE WAS BORN WITH A CLEFT AND HE COULD NOT HAVE A FIXED PROSTHESIS. HE RECEIVED HIS TITANIUM FIXTURES IN HIS LOWER JAW FIRST AND LATER IN THE UPPER. IN THE UPPER JAW WE USED AN IMPLANT IN THE ZYGOMA, ALREADY IN THOSE DAYS! THE IMPLANT-BASED REHABILITATION REMAINED FUNCTIONAL UNTIL THE PATIENT PASSED AWAY IN JANUARY 2006. WE WERE VERY HEAVILY CRITICIZED AT THAT TIME BY SO-CALLED PROFESSIONAL EXPERTS IN THE "DENTAL FIELD." AS VOLTAIRE SAID: "IT'S DANGEROUS TO BE RIGHT IN MATTERS ON WHICH THE ESTABLISHED AUTHORITIES ARE WRONG."

ONE WOULD LIKE TO RESTORE THE ANATOMY WITH IMMEDIATE GRAFTS IN CASES WHERE THERE IS A LOSS OF BONE. ONE CAN HOWEVER ALSO PREFORM THE CAPITULUM AND THE HALF-MANDIBLE BY INSERTING A MOLD INTO THE ILIAC BONE. BUT THE QUESTION AROSE WHETHER ONE COULD NOT RATHER ASK MOTHER NATURE TO PARTICIPATE?  

**Fig 3** Larssen being born with a cleft and therefore unable to retain a fixed prosthesis, titanium fixtures were placed first into his mandible and then into his maxilla, where a zygoma implant was used. These titanium fixtures were functional for 41 years.

**Fig 4** The P-I Brånemark Institute Bauru, established in 2005 in Bauru, Brazil.
craniofacial region where bones could be used to anchor fixtures. We tried successfully the zygoma, the pterygoid, the tuberosity. Remarkably enough, even when followed over long periods of time, there was very little problem if surgery was done carefully and gently. Sinoscopies revealed how well the zygoma implants were tolerated within the sinus.

Fig 5  The joints of young patients with severely deformed fingers due to arthritis were opened, the diseased tissue was removed, and spongious bone from the ilium marrow was injected along with blood into the defect. Fixtures were placed in the carpal and metacarpal bones, and an elastic replaceable joint was applied.

In 1992, we started to treat craniofacial defects in Bauru, Brazil, at Centrinho, a center for congenital defects. In 2005, the P-I Bränemark Institute Bauru was established (Fig 4); the clinical activities are based on donations from different quarters, basically from Nobel Biocare. With many volunteers from all over the world, it is possible to treat those patients who do not have the means for it. One should not forget while treating such deformities to try to minimize the procedures. Rather than be academic in our attempts to help those patients, I believe it might be worth asking the patients about their viewpoint or to listen to those who are close to the patients.

What we learned from craniofacial applications was transferred into hand surgery. This was because we were particularly interested in rheumatoid arthritis. There are a large number of young patients who have seriously deformed fingers (Fig 5). We opened the joint, removed the diseased tissue in the marrow cavity by curettage, and then we took from the ilium marrow spongious bone and blood and put them into this defect. Then we put in fixtures in the carpal and metacarpal bones. We then applied, in between those, an elastic replaceable joint. The patient could use these devices for very sensitive tasks.

Fig 6  Fixture-anchored prosthetics were used to replace amputated fingers. The patients could feel and grasp with these prosthetics.

In the 1990s, we treated a series of patients who had had one or several fingers amputated and replaced them with fixture-anchored prostheses (Fig 6). There is generally a very nice skin penetration. Fascinating is that the patient can feel with this and use it to grasp. Göran Lundborg, who is the hand surgeon, evaluated osseoperception. The fixture-anchored prosthesis offered even a better perception threshold than the natural thumb!

This brief summary of half a century of research and clinical endeavors proves that oral health care is an integral part of medicine. It means that we now have a situation where medicine and dentistry should live together.
I hope you will try to simplify procedures and make them more reliable.

The arrangements here, with Domenico Scala and Robert Gottlander of Nobel Biocare, mean that we are coming close to a situation where biology is the key. Let us join forces with the patients and all disciplines involved and remember that the mouth is part of the body.
Daniel van Steenberghe: Multidisciplinary Approach to Patient Treatment

The chairman of the symposium, Daniel van Steenberghe, gave an opening speech to exemplify the need for multidisciplinarity. We are all here to pay a tribute to the lifelong work of Professor P-I Brånemark. You heard him say, even several times, join forces. This brief contribution will try to put this meeting into the perspective of multi- and even preferably interdisciplinarity.

There are too many people in health care, especially among dentists, who think they are Leonardo da Vinci. A recent survey indicates that 95% of university professors are convinced that they are better teachers than the average. This also happens among clinicians, I was told. In Leonardo’s epoch, knowledge was limited to a few hundred books, which still allowed having a global overview. Today we are confronted with an enormous amount of knowledge—more than 3,000 medical journals are listed in PubMed—that no one can assimilate, not even in his own (sub)specialty. If one wants to provide the best of care to patients, based on available knowledge, he or she should join forces with other experts.

The definition of multidisciplinarity in health care is cooperation among clinicians with different backgrounds. One should move from multidisciplinarity to interdisciplinarity, which implies interaction, regular consulting, and coordination of treatment tracks. Such a patient-centered approach, with mutual respect for each clinician’s educational background, can only improve the level of treatment. There is, however, a tendency in oral health care, even for complicated treatment options, for clinicians to expand their field of competence toward surgery even if they are not trained for it. These clinicians develop surgical skills by accumulating clinical experience through patient treatments in private practice, rather than through a structured university-based hospital internship. The latter leads to a formal recognition monitored by national authorities. Today, some accreditation systems in oral health care are run by co-optation, as in medieval corporations. There is no available argument for why the surgical phase of osseointegration-based rehabilitation would be handled differently according to the anatomical location. Improper surgical training can lead, for example, to unnecessary prescriptions for antibiotics. One striking example is the images of oral surgery in which patients are covered by sterile drapes but have the nose uncovered. The latter appears to be the most infected area in the craniofacial area.

Cross-fertilization is why we have this multidisciplinary, hopefully even interdisciplinary symposium. It reaches from hand to maxillofacial surgery and from ENT to periodontology, from dentistry to molecular biology. We also go back in time: Exactly 25 years ago, in 1984, Professor Brånemark asked me to organize a Tissue Integration Congress in Brussels, where this interdisciplinary format was initiated: basic sciences and intra- and extra-oral applications of osseointegration. This led to the book of proceedings, Tissue Integration in Oral and Maxillofacial Reconstruction (Excerpta Medica).

I wish to congratulate Nobel Biocare for its openness of mind in providing all support for this scientific symposium while not controlling the program or selection of speakers.
Bone Physiology and Implant Biomechanics
(Moderator: Georg Watzek)

Christer Slotte, DDS, PhD; Maria Lennerås, MSc; Catharina Göthberg, DD; Felicia Suska, DDS, PhD; Neven Zoric, MSc; Peter Thomsen, MD, PhD; Ulf Nannmark, DDS, PhD
Gene Expression of Inflammation and Bone Healing in Peri-Implant Crevicular Fluid After Placement and Loading of Oral Implants: A Kinetic Clinical Pilot Study Using Quantitative Real-Time Polymerase Chain Reaction

John B. Brunski, PhD; Jennifer Currey, PhD; Jill A. Helms, DDS, PhD; Phillip Leucht, MD; Antonio Nanci, PhD; Rima Wazen, PhD
Implant Geometry, Interfacial Strain, and Mechanobiology of Oral Implants Revisited

Ulf M. E. Wikesjö, DDS, DMD, PhD; Jaebum Lee, DDS, MSc, PhD; Cristiano Susin, DDS, MSD, PhD
Bone, Bone Morphogenetic Protein-2, and Implant Dentistry: A Focused Review
Peter Thomsen: Introductory Remarks

Per-Ingvar Brånemark is definitely a pioneer in the field of interdisciplinary research but also a pioneer in something which today is a hype word: translational medicine.

With the advent of osseointegration, the criteria for biocompatible materials for use in the living bone were for the first time successfully formulated. Basic scientific studies on osseointegration may seem irrelevant nowadays, since we know it already works, but we remain curious. This is because we believe that if we find the fundamental mechanisms to explain osseointegration, this knowledge may be used in the future to further address additional indications or simplify present therapies.
Gene Expression of Inflammation and Bone Healing in Peri-Implant Crevicular Fluid After Placement and Loading of Oral Implants: A Kinetic Clinical Pilot Study Using Quantitative Real-Time Polymerase Chain Reaction

Christer Slotte, DDS, PhD; Maria Lennerås, MSc; Catharina Göthberg, DD; Felicia Suska, DDS, PhD; Neven Zoric, MSc; Peter Thomsen, MD, PhD; Ulf Nannmark, DDS, PhD

Introduction

Early detection of healing complications after placement of endosseous oral implants is a vital but elusive goal. At present, clinical diagnostic parameters include probing of the peri-implant mucosa and radiologic marginal bone level assessments. In addition, implant stability can be assessed by percussion (eg, Periotest\textsuperscript{1,2}), although more objective stability tests are available, eg, resonance frequency analysis (RFA) (Oststell).\textsuperscript{3} RFA has been thoroughly studied and validated by removal torque testing in vitro and in animal models.\textsuperscript{4–9} In addition, clinical reports have demonstrated the benefits of the latter biomechanical assessment, especially in compromised implant cases or when immediate or early implant loading is performed.\textsuperscript{10,11}

Various techniques have been used to analyze the molecular activities in the peri-implant crevicular fluid (PICF), as well as in the gingival crevicular fluid. In PICF, to assess protein products, enzyme-linked immunosorbent assays,\textsuperscript{12–17} Periocheck (a colorimetric technique assessing neutral proteolytic enzyme activity\textsuperscript{18}), immunoblotting,\textsuperscript{19–22} radioimmunoassay,\textsuperscript{23} and spectrophotometric techniques\textsuperscript{24} have been used. To analyze gene expression, semiquantitative real-time polymerase chain reaction (RT-PCR) has been used.\textsuperscript{20}

Quantitative PCR (qPCR) represents a promising new tool to analyze and quantify spatially and temporally the biologic processes in bone at a high level of accuracy.\textsuperscript{25} It has been used in many in vitro studies in relation to bone cells\textsuperscript{26–30} and also recently in vivo.\textsuperscript{31–33} However, to date, no studies have used qPCR to analyze PICF or gingival crevicular fluid in general or to assess the inflammation of tissues around healing implants.

The aim of the present study was to test qPCR as a noninvasive diagnostic tool for the monitoring of healing-specific and peri-implant disease–specific genes as a complement to clinical evaluations.

Materials and Methods

Patients

Eighteen consecutive partially edentulous patients were enrolled in a prospective randomized controlled trial of immediate and delayed loading of oral implants.\textsuperscript{34} Briefly, the patients,
so that the chitosan/rhBMP-2 coating could be tested as a possible bone augmentation agent around the implants. Figures 3c to 3f correspond to samples harvested 3 weeks after the surgery. All images showed large amounts of newly formed bone around the coated screws in just 3 weeks. This confirms the osteoinductive properties of the coating on titanium screws, similar to the osteoinduction seen around commercially available dental implants.

**Model 4**

This investigation was performed in rabbit muscular tissue, similar to that previously shown (Fig 2), to corroborate the ectopic bone formation ability of the coating onto the ceramics (data not shown).
Model 5

At this point in the development of the chitosan/BMP-2 concept, both biodegradable (ie, β-TCP) and nonbiodegradable (ie, HA) porous ceramic materials were considered to be coatable with chitosan/rhBMP-2 films. The porous ceramics are considered to be osteoconductive materials because of their porosity, which allows bone ingrowth from the surrounding material to the inside of the ceramic structure. Given the large amount of bone formed in the described in vivo assays, we wondered whether the osteoinductive effect of the coating and the osteoconductive effect of the porous ceramics would synergistically improve bone formation capacity through these materials.

Porous β-TCP ceramics (Fig 4a) were therefore coated with chitosan or rhBMP-2 and implanted in noncritical-sized rabbit cranial defects (Figs 4b and 4c), an extensively used animal model for bone tissue regeneration assays. Control scaffolds and rhBMP-2 surface–adsorbed scaffolds were also implanted for comparison. The control scaffolds did not show bone formation (Figs 4d to 4f). In contrast, rhBMP-2–adsorbed (Figs 4g to 4i) and chitosan/rhBMP-2–coated (Figs 4j to 4l) implants showed partial degradation of the β-TCP ceramic material and replacement by newly formed bone as a result of the osteoinductivity of the rhBMP-2. However, this process was quantitatively and qualitatively better in the coated samples.

Fig 3 Bone formation in the rabbit tibia in model 3. (a) SEM of a chitosan/rhBMP-2–coated implant. Arrows = film on the implant surface. (b) Implantation of the titanium screws in rabbit tibial plateau. (c) Radiographs of samples 3 weeks after surgery. The tibia on the left corresponds to control screws, and the tibia on the right corresponds to coated screws. Note the large amount of radiopaque tissue formed around the coated implants. (d) µCT image of a coated implant (white = implant; red = bone; dotted line = limit of native bone). (e and f) Histologic samples from a control site (e) and a chitosan/BMP-2–coated implant (f).