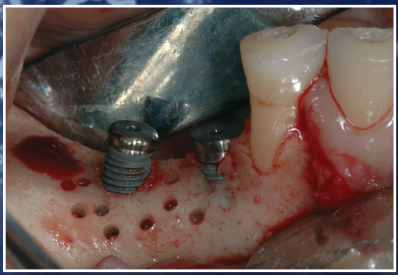
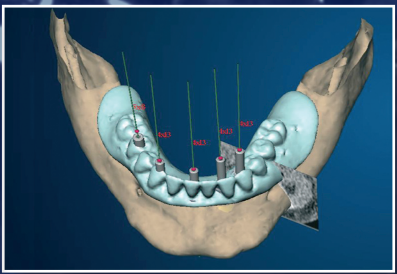
Osseointegration and Dental Implants





Asbjorn Jokstad

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Osseointegration and Dental Implants

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Edited by Asbjorn Jokstad, DDS, PhD

WILEY-BLACKWELL
A John Wiley & Sons, Inc., Publication

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Edition first published 2008
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Blackwell Munksgaard, formerly an imprint of Blackwell Publishing, was acquired by John Wiley & Sons in February 2007. Blackwell's publishing programme has been merged with Wiley's global Scientific, Technical, and Medical business to form Wiley-Blackwell.

Editorial Office
2121 State Avenue, Ames, Iowa 50014-8300, USA

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Library of Congress Cataloguing-in-Publication Data

Toronto Osseointegration Conference Revisited (2008 : Toronto, Canada)
Osseointegration and dental implants / [edited by] Asbjorn Jokstad.
p. ; cm.
Based on the proceedings of the Toronto Osseointegration Conference Revisited, which took place on May 8–10, 2008.
Includes bibliographical references and index.
ISBN-13: 978-0-8138-1341-7 (alk. paper)
ISBN-10: 0-8138-1341-7 (alk. paper)
1. Dental implants–Congresses. 2. Osseointegration–Congresses. I. Jokstad, Asbjorn. II. Title.
[DNLM: 1. Dental Implantation–methods–Congresses. 2. Osseointegration–Congresses. 3. Dental Implants–Congresses. WU 640 T686o 2008]
RK667.I45T67 2008
617.6′92–dc22

2008033209

A catalogue record for this book is available from the U.S. Library of Congress.

Set in 10 on 12 pt Sabon by SNP Best-set Typesetter Ltd., Hong Kong
Printed in Singapore by Fabulous Printers Pte Ltd

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1 2008

Contents

Foreword

The 2008 Toronto Osseointegration Conference Revisited and this book would not have been possible without the enthusiastic support of everyone involved.

We are grateful to our conference speakers and especially the individuals who spent time putting on paper what they consider are the important messages to be conveyed.

We thank our industry sponsors for supporting the conference, and our participating associations and journals for their cooperation in selecting speakers and program themes. We also express gratitude to everybody who shared our ambition to organize a conference with a main purpose to critically appraise where we have come from and where we are heading within the field of implant dentistry.

Enormous thanks is extended to my husband and editor of this book, Asbjorn Jokstad. This book would never have been written without his indefatigable energy and desire to share scientific knowledge with dentists and researchers throughout the world.

Dr. Anne M. Gussgard, DDS
Steering Committee Chair
Toronto Osseointegration Conference
Revisited, May 9–10, 2008

Preface

Osseointegration and implant dentistry research are at an unprecedented peak. More than one million dentists worldwide are ready to learn more about implant practices and eager to offer implant solutions to their patients. The consequence is that the market today is saturated with new implant manufacturers, new implant brands, new surfaces, and new marketing strategies. Some say this is history repeating itself, that the field has regressed to the implant dentistry practices and research preceding the first Toronto Osseointegration Conference, which was organized by Professor Emeritus George A. Zarb in 1982.

A 25-year mark is a good point to call a time-out, to take stock of our accomplishments, and to question where we have come from, where we are, and where we seem to be heading. By learning from our past mistakes, we may better be able to meet the future. What have we achieved over the last 25 years and what are emerging as new and innovative developments in the field of osseointegration? This textbook attempts to answer these questions by reflecting on the many significant developments of the current and future application of implants to support intra and extraoral prostheses. A sincere thank you to all colleagues who have shared this vision and contributed to the Toronto Osseointegration Conference Revisited and to this textbook.

Asbjorn Jokstad, DDS, Dr. Odont.
Toronto, May 10, 2008

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Introduction

Asbjorn Jokstad

The improvements in implant technology and its practical application in the clinic are not a function primarily of one specific implant surface, a treatment procedure, or some particular loading protocol. Rather it can be understood by conceptualizing the individual elements involved in placing one or more endosseous implants to support an intraoral prosthesis. It is the refinement of each of these individual elements that has contributed to the understanding of osseointegration itself, and improved the technology to solve our patients' problems even further. The chapters that have been included in this collection reflect these elements. Three intertwined treatment planning phases can be identified in the practical application process: a total treatment planning strategy (chapters 2, 3, and 4); a surgery planning strategy (chapter 5); and a restorative planning strategy (chapters 15 and 16). These planning phases take into account patient-centered considerations, for example, risk factors (chapters 3 and 4), healing predictability (chapters 11, 12, and 13), and consideration of the probabilities of possible outcomes of implant interventions (chapters 18, 19, 20, 21, and 22). The actual interventions fall into four categories, that is, the diagnostic and pre-surgical (chapters 6, 7, and 8), the surgical (chapter 10), and the restorative (chapter 14), although at times some of these converge. Each intervention involves the use of different biomaterials for possible site optimizing (chapter 9) and ultimately for the different components of the supra-construction (chapter 17). The observant reader may recognize that the chapter theme order follows the natural progression in the everyday clinical treatment situation. Complementing these practical elements of implant therapy are the three remaining chapters on the assessment of technology in implant therapy (chapter 1), educational requirements for practice (chapter 24), and use of craniofacial and dental implants in adolescent children (chapter 23).

Chapter 1: Any 4-year-old child is able to ask the three essential questions in life—what do we know?, how can you say?, and why should I? More learned scholars would categorize these questions using the more philosophical terms ontology, epistemology, and ethics. The chapter describes what we know about implant therapy outcomes, how we should interpret the claims in the literature, and on which theoretical basis the practicing community should be guided.

Chapter 2: The comprehensive treatment planning phase is the most crucial element determining a successful or unsuccessful treatment outcome. Experience has shown us that it is difficult, or at worst impossible, to achieve an optimal result if this essential factor is neglected. This chapter describes how multifaceted treatment planning needs to be in order to attain a high probability of treatment success.

Chapter 3: Patients with complex rehabilitation problems remain a challenge for the clinician, whether their condition is due to medical factors, multimorbidity, or old age. This chapter describes how acceptable treatment results from a functional, psychological, and psychosocial aspect can be achieved in sometimes very difficult situations.

Chapter 4: Do periodontal inflammation and/or infection increase the risks for systemic medical conditions? If drawing a parallel with patients with multiple implants, can it be inferred that inflammatory disease in gingival tissues surrounding endosseous implants might also affect the patient's systemic health? This chapter presents new knowledge that needs to be considered when planning treatment in patients with current or past history of refractory periodontitis and/or peri-implantitis.

Chapter 5: Placing an endosseous dental implant always involves some element of risk of adverse events. One important role of the surgeon is to be cognizant of the factors associated with risks, to assess to which extent they apply to the particular patient at hand, and to convey the estimated risk to the patient before commencing treatment. This chapter presents recent findings that challenge our perceptions of risk associated with implant surgery. Do we still have to avoid placing implants in infected sites at all costs? Moreover, are the margins of operator error reduced in special circumstances, for example, by using computer-assisted implant surgery when there is questionable bone volume or bone quality or proximity to vital anatomical structures?

Chapter 6: In most cases optimal aesthetics and function with implant-supported prosthetics can be achieved after a vertical and/or horizontal regeneration of damaged hard and soft tissues. We have moved from using solely autologous bone and soft-tissue transplants from remote sites to adopting new alloplastic materials, either used alone or in combination with autologous bone and various cell constituents, with the ultimate aim of improving biomimetics. This chapter describes the current state of the science and suggestions for clinical practice.

Chapter 7: For the patient with the atrophic jaw more invasive surgical grafting procedures are needed to reconstruct the resorbed bone. Both inlay and onlay grafts as well as interpositional bone grafts are common techniques that are used in individual situations where the benefit is weighed against possible added treatment length and morbidity. Hard tissue augmentation needs in implant dentistry are also influenced by upcoming new products and applications. This chapter describes how advances in bioengineering now enable new treatment concepts for the reconstruction of atrophic jaws in combination with implants.

Chapter 8: It has always been a challenge to restore the edentulous posterior maxilla with implant-supported prostheses. The advent of implants with new surfaces has only partially improved the situation. Various innovative approaches for grafting into and onto the sinus have been developed and this chapter describes the current surgical techniques, new bioengineering materials, and new research avenues.

Chapter 9: The enormous advances made in developing innovative recombinant-DNA techniques enable us today to use extracellular matrix proteins. Although their exact role in the healing process cascade is currently not fully understood, it appears that they have an important therapeutic utility. This chapter describes the state of the science on regeneration techniques related to dental implant technologies.

Chapter 10: Computer-assisted tools for diagnosis and surgical placement were relatively rapidly adopted by implant surgeons. These digital technologies have now evolved even further and can be applied in treatment planning both to the implant placement and the complete temporary or permanent restoration. This chapter describes how these new digital technologies can be applied, and their potential to improve surgical and restorative treatment outcomes.

Chapter 11: Implant micromotion has an effect on bone healing, but the relationship between the two is complex. For example, do variations in the macro- and micromorphology of the implant influence this relationship? This chapter presents new experimental data that underpin what the leading authorities today believe is the current understanding of the association between implant morphology, micromotion, and healing responses of the bone.

Chapter 12: We are bombarded with “improved” implants with “improved” surfaces. How much of the endless focus on morphological differences is hype and how much is substantiated by sound research? The association between implant surfaces and osteogenesis remains elusive. Surface modifications are motivated by findings from advanced molecular and cellular biology research, combined with advanced bioengineering experiments. This chapter provides perspectives on which implant surfaces will most likely continue to evolve over the next few years and which will falter.

Chapter 13: Many clinicians today believe that the first generation of titanium implants with a turned surface demonstrate less favorable and predictive clinical outcomes compared to implants with other surface geometries, especially in specific intraoral locations. It is intriguing that we are not really sure why, whether it is due to biological width, osteoinduction or -conduction, stress transfer to cortical bone, or other explanations. This chapter describes the current understanding of how the geometries and surface topographies of dental implants can be related to bone responses.

Chapter 14: Have we arrived at the stage where improved grafting materials, implant design and surfaces, and innovative surgical approaches can accelerate the biological responses or is this just wishful thinking? Does it carry any significance that such results can be demonstrated in, for example, rabbits or rats, and should we take it for granted that we can generalize what will happen clinically from laboratory and animal experiments? This chapter examines what is imagination and what is the clinical reality.

Chapter 15: Planning the right technical solution for the right patient, one that will not fail in the foreseeable future, requires more than a clinician’s delicate touch. This chapter presents two different, but complementary, principles for restorative treatment planning that have been shown to minimize the risk of adverse biological and mechanical events.

Chapter 16: The finer details of the planning and execution of interventions may result in treatment success or failure. Particularly when shortened clinical loading protocols are used, seemingly minor clinical factors need to be taken into consideration, while making us reconsider some tenets of implant-abutment connection and immediate and early loading in osseointegration that have remained unchallenged.

Chapter 17: New prosthetic components to attach between the endosseous implant and the supra-construction, as well as the supra-construction itself, are developed using a wide range of biomaterials, and by using computer-assisted design and/or manufacture. The benefits for the patient are more individualized technical solutions with optimal aesthetic results, and custom-designed three-dimensional form with improved fit between the components, adapted to functional requirements. The chapter details the merits and disadvantages of current technologies as well as the history and future of this development.

Chapter 18: When the bone mass is limited or of a quality that does not allow the placement of routine dental implants, the clinician is faced with the option to create bone by grafting. Cost-benefit considerations and perceived risks of associated morbidity caused by invasive surgery may exclude this treatment option. Fortunately, specially designed implants can be used in clinical situations where the placement of standard implants will be contraindicated. This chapter presents data that underpins an association between implant design and clinical outcomes.

Chapter 19: Before Brånemark, oral implants were commonly loaded at placement because it was believed that an immediate loading stimulation resulted in less crestal bone loss. The idea never disappeared completely and in fact has gained acceptance in the last few years. This chapter presents and debates the scientific foundation and clinical risks and benefits as reflected from basic, translational animal, and clinical studies.

Chapter 20: We are aware of the importance of somatosensory nerve fibers for recognizing potentially damaging thermal, mechanical, and painful stimuli. In addition, periodontal mechanoreceptors respond to occlusal loads and enable a fine motor control of tooth contacts through complex central and peripheral neural interactions. Implants supporting various forms of suprastructures induce different regulation mechanisms. Moreover, the neurophysiological consequences of the actual implant placement in terms of postoperative sensitivity and pain remain an active focus of research. This chapter presents the relationships between elements of the implant suprastructure occlusion, function and dysfunction, pain, and basic CNS mechanisms.

Chapter 21: There are no medical interventions that can be called truly predictive, nor is it obvious which outcomes best describe the efficacy of interventions. Some outcomes are of great significance for many patients but do not necessarily concern others. While the clinical researchers have slowly moved from recording and reporting surrogate outcomes of implant therapies, modern clinical research focuses more on patient-centered outcomes that matter both to the individual patients and those responsible for public health planning. This chapter reviews how treatment outcomes were evaluated earlier, and how these are being gradually replaced by novel ways of appraising outcomes that are more meaningful for our patients.

Chapter 22: The term "implant therapy" is regarded by many as a misnomer since one does not cure nor manage diseases or disorders with an implanted object. Implants are only adjuncts, albeit very effective, to securely retain dental (i.e., intraoral) or maxillofacial (i.e., extraoral) prostheses. These prostheses in turn are made to enable patients with various amounts of tissue loss to regain a certain degree of oral function, acceptable appearance, and for some socially dysfunctional patients, even their confidence to the extent that they are able to return to a normal social life. A common denominator for many patients receiving implant-supported prostheses is improved quality of life, which does not necessarily depend on the sophistication of the technical solution that the dentist offers. This chapter elaborates on how these factors are interdependent and are of importance for both provider and patients.

Chapter 23: Maxillofacial deformities, whether due to ablative surgery, congenital defects, or trauma, can be masked or restored by artful design and skillful manufacturing of highly individualized prostheses and by using a wide range of biomaterials. Nevertheless, the advent of oral and craniomandibular implants has dramatically increased even further the possibilities of achieving optimal results from functional and aesthetic perspectives. The outcomes are especially critical when treating children and adolescents, and this chapter presents an outstanding panorama of challenges, solutions, and experiences with these patients.

Chapter 24: Implant therapy is usually not a component in the undergraduate curriculum in most dental faculties worldwide. The new graduate as well as the experienced practitioner has to identify and deduce which implant course provider can supply the essential information and basic knowledge required for the clinician to provide safe and efficacious implant therapy. The question is, where can you learn enough to place implants? And what is “enough”?

Osseointegration and Dental Implants

1 Implant Dentistry: A Technology Assessment

HOW MANY IMPLANT SYSTEMS DO WE HAVE AND ARE THEY DOCUMENTED?

Asbjorn Jokstad

Introduction

We have today close to 600 different implant systems produced by at least 146 different manufacturers located in all corners of the globe. Last year alone, at least 27 new dental implant companies surfaced in the market (Table 1.1).

Is anybody troubled? At least some representatives of the profession have expressed their concern about the seemingly unstoppable avalanche of new implants. Alarm was raised in the United States in 1988 about the heterogeneity of implant designs and the effectiveness of the then 45 different implant systems (English 1988). One of the world's foremost experts in the field, Dr. Patrick Henry, in 1995 challenged the profession and the industry and asked whether implant hardware changes should be regarded as science or just commodity development. He may perhaps have succeeded in slowing down the output of new products, at least for a few years, since by the year 2000 the number of implant systems had increased "only" to 98 (Binon 2000). Not only did the quantitative issue cause concern, but also the qualitative aspects. Were these new implants really clinically documented? No, according to Albrektsson and Sennerby (1991); no, according to the American Dental Association (ADA 1996); no, according to Eckert and colleagues (1997); and no, according to several other investigators publishing at the time. Around the turn of the millennium the FDI World Dental Federation was alarmed by the apparent rapid increase in the number of implants and implant systems worldwide, and questions were raised about the quality of all the new implants that were being marketed. The FDI Science Committee was asked to investigate the issue and the findings were rather alarming (Jokstad et al. 2003). The investigators identified 225 implant brands from 78 manufacturers, but also discovered that about 70 implant brands were no longer being manufactured. Of the 78 manufacturers, 10 could support their implant system with more than four clinical trials, 11 could support their

Table 1.1. Implant producers of the world.

1.	ACE Surgical Supply Company	USA
2.	Adaptare Sistema de Implantate	Brazil
3.	Advance Company	Japan
4.	Allmed S.r.l.	Italy
5.	Almitech Incorporated	USA
6.	Alpha Bio GmbH	Germany
7.	Alpha Bio Implant Limited	Israel
8.	Altiva Corporation	USA
9.	Anthogyr	France
10.	AQB Implant System	Japan
11.	AS Technology	Brazil
12.	Astra Tech	Sweden
13.	Basic Dental Implants LLC	USA
14.	BEGO Implant Systems GmbH & Co. KG	Germany
15.	Bicon Dental Implants	USA
16.	BioHex Corporation (previous name: Biomedical Implant Technology)	Canada
17.	BioHorizons Implant Systems Incorporated	USA
18.	Bio-Lok International Incorporated (subsidiary of Orthogen Corporation)	USA
19.	Biomaterials Korea	South Korea
20.	Biomedicare Company	USA
21.	Biomet 3i Implant Innovations Incorporated	USA
22.	Bionnovation	Brazil
23.	Biost S.n.c.	Italy
24.	Biotech International	France
25.	Blue Sky Bio LLC	USA
26.	Bone System	Italy
27.	BPI Biologisch Physikalische Implantate GmbH	Germany
28.	BrainBase Corporation	Japan
29.	Brasseler Group (Gebr. Brasseler GmbH & Co. KG)	Germany
30.	Bredent Medical	Germany
31.	BTI Biotechnology Institute S.L.	Spain
32.	Btlock S.r.l.	Italy
33.	Buck Medical Research	USA
34.	Camlog Group (previous name: Altatec)	Switzerland
35.	Ceradyne Incorporated	USA
36.	CeraRoot	Spain
37.	Clinical House Europe GmbH	Switzerland
38.	Conexão Implant System	Brazil
39.	Cowell Medi Company Limited	South Korea
40.	CSM Implant	South Korea
41.	Curasan AG	Germany
42.	De Bortoli ACE	Brazil
43.	Dental Ratio Systems GmbH	Germany
44.	Dental Tech	Italy
45.	Dentatus	Sweden
46.	Dentaurum J.P. Winkelstroeter KG	Germany
47.	Dentium	South Korea
48.	Dentoflex Comércio e Indústria de Materiais Odontológicos	Brazil
49.	Dentos Incorporated	South Korea
50.	Dentsply Friadent Ceramed Incorporated (Friadent GmbH Germany)	USA
51.	DIO Implant	South Korea
52.	Dr Ihde Dental GmbH	Germany
53.	Dyna Dental Engineering b.v.	Netherlands
54.	Eckermann Laboratorium	Spain
55.	Elite Medica	Italy
56.	Europäische Akademie für Sofort-Implantologie	Germany
57.	Euroteknika	France

Table 1.1. *Continued*

58.	GC Implant System	Japan
59.	General Implant Research System	Spain
60.	Global Dental Corporation	USA
61.	Hi-Tec Implants Limited	Israel
62.	Impladent Limited	USA
63.	Implamed S.r.l.	Italy
64.	Implant Direct LLC	USA
65.	Implant Logic Systems	USA
66.	Implant Media S.A. (outsourcing manufacturing plant)	Spain
67.	Implant Microdent System S.L.	Spain
68.	Implantkopp	Brazil
69.	IMTEC Corporation	USA
70.	Institut Straumann AG	Switzerland
71.	Interdental S.r.l.	Italy
72.	International Defcon Group	Spain
73.	Intra-Lock System International	USA
74.	Ishifu Metal Industry Incorporated	Japan
75.	Japan Medical Materials Corporation	Japan
76.	Jeil Medical Corporation	South Korea
77.	jmp dental GmbH	Germany
78.	JOTA AG	Switzerland
79.	Klockner Implants	Spain
80.	LASAK Limited	Czech Republic
81.	Leader Italy S.r.l.	Italy
82.	Leone S.p.A.	Italy
83.	Lifecore Biomedical Incorporated	USA
84.	Maxon ceramic	Germany
85.	Medentis Medical	Germany
86.	Megagen	South Korea
87.	MIS Implant Technologies Limited Company (MIS)	Israel
88.	Mozo-Grau	Spain
89.	Neobiotech Company Limited	South Korea
90.	Neodent	Brazil
91.	Neoss Dental Implant System	UK
92.	Nobel Biocare	Sweden
93.	OCO Biomedical (previous name: O Company Incorporated)	USA
94.	Odontit S.A.	Argentina
95.	OGA implant	Japan
96.	o.m.t (previous name: Biocer)	Germany
97.	Oral implant S.r.l.	Italy
98.	Osfix Limited	Finland
99.	Ospol AB	Sweden
100.	Osstem Company Limited	South Korea
101.	Osteocare Implant System Limited	UK
102.	Osteo-Implant Corporation	USA
103.	Osteoplant	Poland
104.	Osteo-Ti	UK
105.	PACE™ Dental Technologies Incorporated (Renick Enterprises Incorporated)	USA
106.	Paraplant 2000	Germany
107.	Paris implants	France
108.	Park Dental Research Corporation	USA
109.	Pedrazzini Dental Technologie	Germany
110.	PHI S.r.l.	Italy
111.	Poligono Industrail MasD'En Cisa	Spain
112.	Qualibond Implantat GmbH	Germany
113.	Quantum Implants	USA
114.	Renew Biocare	USA