Implant Dentistry at a Glance

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Preface

In the 1970s, the biological concept of osseointegration applied to the dental field changed the face of dentistry by offering us a completely new approach to the treatment of edentulism (Brånemark et al., 1977). However, dental implant therapy is a relatively young area of interest in dentistry. This textbook, designed to cover the essentials of dental implant therapy, was a challenging undertaking because unknowns still exist, and part of the decision-making process is based on personal experience of clinicians. We made an effort to emphasize the evidence-based approach when information was available. Nevertheless, some of the chapters are based on our personal experience in dental implant therapy and may therefore be challenged by other clinicians according to their skills.

Based on the above considerations, the present book does not deal with all types of dental implants but with the threaded root-form osseointegrated implants, which are the most used in practice and the best documented in the medical literature.

Our work is adapted to the needs and use of the general practitioner and students; consequently all the surgical procedures described in the present volume can be performed under local anesthesia. In the same vein, we do not include sophisticated procedures such as zygomatic implants that are beyond the scope of our intention. However, we also hope that this book may help the specialist in his/her decision-making process.

The number of dentists placing dental implants is increasing annually. Markets for dental implants are anticipated to reach $8.1 billion by 2015 (WinterGreen Research Report, 2009). More than 1000 types of dental implants are commercially available and are manufactured by competing companies. In Europe, four companies capture close to 60% of the market (Millennium Research Group, 2009). It is understandable that companies actively participate in basic and clinical research as well as in the continuing education of general practitioners.

We have tried, as much as possible, to avoid the pitfalls of commercial pressure, striving to avoid brand citations and adhering closely to the basic principles of implant therapy.

Dental implant therapy deals with two inter-related components: dental implant placement and achievement of the implant-retained prosthesis. The first is a surgical procedure; the second is the visible part of the iceberg, i.e. the procedure of replacing missing teeth by artificial reconstructions that mimic natural ones. It may be assumed that any general practitioner or, preferably, any integrated dental team can perform, with minimal training, both the surgical and the prosthetic procedures in simple cases. However, tremendous advances in dental implant surgery have increased the complexity of the techniques and the indications for dental implant therapy. We thus decided to emphasize the surgical part of this textbook in order to highlight the broader indications that are nowadays possible thanks to new surgical approaches. Excellent textbooks that detail prosthetic procedures in dental implant reconstruction are available.

It is evident that the biological concept of osseointegration has introduced one of the most significant breakthroughs in clinical dentistry over the past quarter century. The use of osseointegrated dental implants is now considered as a predictable treatment of partial and full edentulism. Bone and soft tissue augmentation procedures have expanded the treatment options, allowing dental implant placement in almost all clinical situations. Advances in the use of growth factors for the treatment of localized ridge augmentation are promising.

Recent data on the survival rate of short implants (less than 10 mm) may challenge the use of sophisticated surgeries. In addition, new ultrasonic surgery units, surgical instruments, and products have improved the quality of the procedures and patient comfort. Thus, a functional and cosmetic implant-borne restoration can be provided to the wide majority of patients, even if esthetics remains the most challenging criterion to fulfill.

Apart from rare, strict medical contraindications, dental implant therapy seems to be a “no-limit” approach for the replacement of missing teeth. The extraordinary confidence in dental implants has positioned implant dentistry at the forefront of treatment choices for any type of edentulism, leading to extraction of teeth that may be treatable using conventional procedures. Although an overall 19-year survival rate of 82–94% has been reported in oral implants, we must keep in mind that tooth longevity in well-maintained periodontal patients surpasses implant longevity after 10 years of observation (Holm-Pedersen et al., 2007). Thus, the dentist should counsel the patient to retain their teeth if possible.

Finally, one of the major drawbacks of dental implant therapy is its immediate cost. Several studies have found that the prevalence of tooth loss was higher in low socio-economic groups than in high socio-economic groups. Consequently, dental implant therapies are strongly beneficial for low-income patients. In the 1990s, the tendency of some clinicians to install as many implants as possible in full edentulism was questioned (Brånemark et al., 1995). Currently, a mandibular two-implant overdenture is the minimum standard of care for edentulous patients (Feine, 2002). In other situations, it has been shown that the retention throughout life of a minimum of 20 teeth with 9–10 pairs of contacting units, including anterior teeth, is sufficient for adequate masticatory efficiency and masticatory ability (WHO, 1992; Gottfredsen & Walls, 2007). This minimum goal can often be achieved by implant-supported prostheses. Based on these findings, it is possible to improve the quality of life of edentulous patients by using a limited number of implants, which reduces the overall cost of the procedure.

We hope that this book will help the reader to better understand the clinical advantages and technical limits of this revolution that is dental implant therapy. We also hope that the reader will never forget that any elective procedure in the field of medical care aims to improve quality of life, and therefore must be centered on patient expectations.

Philippe Bouchard

References


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### List of abbreviations

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<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AED</td>
<td>automated external defibrillator</td>
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<tr>
<td>APF</td>
<td>apically positioned flap</td>
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<td>BBM</td>
<td>bovine bone mineral</td>
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<td>BIC</td>
<td>bone-to-implant contact</td>
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<td>BMP</td>
<td>bone morphogenetic proteins</td>
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<td>BOP</td>
<td>bleeding on probing</td>
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<td>BRONJ</td>
<td>bisphosphonate-related osteonecrosis of the jaw</td>
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<tr>
<td>CBCT</td>
<td>cone beam computed tomography</td>
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<tr>
<td>CT</td>
<td>computed tomography</td>
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<tr>
<td>DBB</td>
<td>deproteinized bovine bone</td>
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<tr>
<td>DFDB</td>
<td>demineralized freeze-dried bone</td>
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<tr>
<td>e-PTFE</td>
<td>expanded polytetrafluoroethylene</td>
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<tr>
<td>FGG</td>
<td>free gingival graft</td>
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<tr>
<td>FPD</td>
<td>fixed partial denture</td>
</tr>
<tr>
<td>FPD</td>
<td>fixed partial dental prosthesis</td>
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<tr>
<td>GBR</td>
<td>guided bone regeneration</td>
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<tr>
<td>IRO</td>
<td>implant-retained overdenture</td>
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<tr>
<td>ISC</td>
<td>implant single crown</td>
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<tr>
<td>ISR</td>
<td>implant survival rate</td>
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<tr>
<td>NSAID</td>
<td>non-steroidal anti-inflammatory drug</td>
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<tr>
<td>OFD</td>
<td>open flap debridement</td>
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<tr>
<td>OR</td>
<td>odd ratio</td>
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<tr>
<td>PD</td>
<td>probing depth</td>
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<tr>
<td>PRP</td>
<td>platelet-rich plasma</td>
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<tr>
<td>PTFE</td>
<td>polytetrafluoroethylene</td>
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<tr>
<td>RF</td>
<td>rotational flap</td>
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<tr>
<td>SECTG</td>
<td>subepithelial connective tissue graft</td>
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Figure 1.1 Healing phases of “non-cutting” dental implants placed in Labrador dogs (Berglundh et al., 2003). (A,B) Four days of healing. The fibrin clot has been replaced by granulation tissue. (C) One week. Woven bone formation. (D,E) Four weeks. The newly formed bone includes woven bone combined with lamellar bone. In the pitch regions, the bone remodeling appears to be intense (E). (F) Twelve weeks. Mature bone (lamellar bone and marrow) is in close contact with the implant and covers most of the surface. Reproduced with permission from John Wiley and Sons.
The aim of the surgical procedure for implant placement is to prepare, in an atraumatic manner, an intraosseous bed into which a dental implant is inserted. Following soft tissue elevation, a channel is drilled into the cortical and spongy bone and the dental implant (screw type titanium device), slightly wider than the channel, is slowly inserted within the “implant bed” (the channel) surgically created.

The compression of the bone surrounding the implant reduces the peripheral vasculature, and the lack of an adequate blood supply leads to a non-vital tissue at the bone/implant interface. The inflammatory response to the surgical injury aims to remove the damaged tissues and to initiate the healing process leading to osseointegration, i.e. the direct connection between newly formed bone and the metal device.

**Implant neck**
The initial stability of the interface between the implant and the mineralized bone is a critical factor to initiate the osseointegration process. The primary stability of the dental implant is often achieved at the cortical bone level. In the cortical compartment at the implant neck, the non-vital lamellar bone is first resorbed before new bone formation occurs onto the implant surface.

**Implant body**
At the implant body, in the cancellous compartment, the wound healing includes the following phases (Berglundh et al., 2003; Abrahamsson et al., 2004).

1 **Clot formation**
The blood fills the space between the threads of the implant. Erythrocytes, neutrophils, and macrophages are trapped in a fibrin network. The fibrin clot is replaced by granulation tissue. Mesenchymal cells and blood vessels proliferate in the new granulation tissue, which is rich in collagen fibers (Fig. 1.1A,B).

2 **Bone modeling**
A first line of osteoblasts, migrating from bone marrow, invades the granulation tissue. After one week an osteoid matrix is observed in the mesenchymal tissues surrounding the blood vessels. In the osteoid, deposition of hydroxyapatite leads to woven bone formation (immature bone). Woven bone formation (Fig. 1.1C) is associated with increased local angiogenesis. The woven bone is characterized by randomly oriented collagen fibrils, numerous osteocytes, and low mineral density. It fills the space between the implant threads, constructing the first bony bridges between the inner bony wall of the surgical channel and the external surface of the dental implant. This direct contact between the woven bone and the implant surface represents the first phase of the osseointegration. Gradually, woven bone covers most of the implant surface.

3 **Bone remodeling**
During subsequent weeks, concentric layers of lamellar bone (osteon) are seen in the newly formed tissue (Fig. 1.1D,E). Woven bone is progressively replaced by lamellar bone and marrow (mature bone) (Fig. 1.1F). The lamellar bone is the strongest type of newly formed bone, and the most elaborate type of bone tissue; it is composed of collagen fibrils densely packed into parallel layers with alternating courses.

**Implant loading**
Micromovements along the bone/implant interface have a tolerance limit during the healing phase, and micromotion beyond this tolerance limit may result in connective tissue encapsulation of the implant body. On the other hand, it has been shown that immediate occlusal loading can present a high level of bone-to-implant contact (BIC) in humans. It must be understood that the degree of achieved primary stability depends on several factors including bone density and quality, implant shape, design and surface characteristics, and surgical technique.

Once the healing phase completed, i.e. after about 3 months, BIC is not 100%. It has been shown that functional loading of dental implants may enhance BIC value (Berglundh et al., 2005). This important finding indicates that the biological process of osseointegration is continuous, related to bone remodeling, and does not stop with the healing phase, and that a site-specific bone adaptation response to mechanical loading may result in increasing osseointegration over time. This emphasizes the importance of controlling the occlusal load as well as the bacterial load during the maintenance phase.

**Key points**
- The surgical technique should be as atraumatic as possible.
- Good primary stability is a key factor in the osseointegration process.
- The degree of achieved primary stability depends on several factors.
- After the healing phase, functional loading of dental implants may enhance BIC value.
The basics: the peri-implant mucosa

Figure 2.1 (A,B) Clinical appearance of the peri-implant mucosa. Red circles indicate the implant-supported prosthesis.

Figure 2.2 Histological differences between tooth and dental implant. AB, alveolar bone; BE, barrier epithelium; BII, bone/implant interface; C, cementum; CT, connective tissue; CTF, connective tissue fibers; GE, gingival epithelium; JE, junctional epithelium; P, periosteum; PIB, peri-implant bone; PIE, peri-implant epithelium; PL, periodontal ligament.

Figure 2.3 The biological width around dental implants.

Mucosal thickness 4 mm

Mucosal thickness 2 mm

2.1 mm

2.0 mm

1.8 mm

1.3 mm

The basics: the peri-implant mucosa

Chapter 2

The connective tissue compartment is in direct contact with the implant surface. The connective fibers are parallel to the implant surface without attachment to the metal body (adhesion). Consequently, the resistance to probing around implants is decreased as compared to that around teeth. However, when probing in healthy tissues, the tip of the probe seems to reach similar levels at the implant and tooth sites. Marginal inflammation around implants is associated with a deeper probe penetration as compared to that around teeth.

Soft tissue components
Compared to the gingiva, the peri-implant mucosa exhibits more collagen fibers, fewer fibroblasts, and fewer vessels.

Soft tissue healing
Due to the lack of the vascular plexus of the periodontal ligament, the implant blood supply comes from two sources: the peri-implant mucosa and the supraperiosteal blood vessels.

A mature barrier epithelium is seen after 8–9 weeks of healing, and the collagen fibers are organized after 4–6 weeks of healing.

The potential for repair is limited due to the:
• lack of periodontal ligament
• reduction of the cellular components of the mucosa
• reduced vascularization.

Soft tissue interface dimensions
The epithelium barrier is about 2 mm long, and the connective tissue seal is 1–1.5 mm high.

These dimensions are maintained whatever the thickness of the mucosa. This means that when the mucosa is thin (i.e., ≤2 mm), bone resorption occurs to maintain these soft tissue dimensions. In short, as for teeth, a biological width must be respected around implants (Fig. 2.3).

Soft tissue seal
The epithelium barrier is sealed to the implant surface via hemidesmosomes and must be considered as identical to that of the epithelial seal around teeth.

Key points
• The peri-implant mucosa is sealed, and not attached to the implant.
• A biological width is maintained, whatever the thickness of the mucosa.
• Compared to the gingiva, the peri-implant mucosa is a scar-like tissue, rich in collagen fibers, poor in fibroblasts, and with limited blood supply.
• The potential for repair is more limited than with gingival tissue.
Chapter 3  The basics: surgical anatomy of the mandible

Figure 3.1  Mandible: mental foramen. Two anatomical variations of the inferior alveolar nerve. (A) Anterior extension: incisive canal. (B) Anterior loop. 1. Inferior alveolar nerve; 2. mental nerve; 3. incisive canal; 4. anterior loop of the inferior alveolar nerve.

Figure 3.2  Mandible: horizontal section/occlusal view. 1. Mandibular foramen; 2. mandibular canal (inferior alveolar nerve); 3. mental foramen; 4. lingual nerve; 5. incisive canal.

Figure 3.3  Mandible: posterior vertical section. 1. Lingual cortex concavity: submandibular fossa; 2. mandibular canal (inferior alveolar nerve); 3. lingual foramen; 4. mental spines: (a) genioglossus, (b) geniohyoid.

Figure 3.4  Mandible: lingual view. 1. Mandibular foramen; 2. lingual nerve.