Evolution from delayed to early loading on Brånemark implants. Clinical implications and case reports

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Oral implants are useful means to replace missing teeth in all kinds of indications with an excellent prognosis (van Steenbergh et al, 1999). 15 years ago some drawbacks existed, mainly due to the limitations in surgical approach, implant design, implant surface configuration and limited restorative options. Modifications in dental implants and biologically oriented clinical research gave us more insight in the mechanism of osseointegration and implant function. Although, some aspects of implant treatment still need to be clarified, oral implants are today the treatment of first choice in many indications.

The original surgical two-stage implant protocol

The original Brånemark protocol advocated implant installation in two stages (Brånemark et al, 1977). It was dogmatically believed that after fixture installation the implant had to be covered by gum to avoid epithelial downgrowth between bone and implants. In order to allow bone to integrate with the titanium-oxide layer covering the implant surface, it was postulated that an implant needed an extended healing time of three months in the mandible and six months in the maxilla (Adell et al, 1981). Often, the patients were not allowed to wear removable dentures during the first weeks after surgery, to minimise the risk for overloading which could jeopardise osseointegration. In the second-stage surgery the implants were exposed and the abutments were connected. After another six to eight weeks healing of the mucosal tissues the prosthetic procedure started. In clinical practice this meant a total treatment period of at least five to six months in the mandible and eight to nine months in the maxilla. These guidelines were, however, empirically based on clinical experience rather than on knowledge of biological principles.

From two-stage to single stage surgery

During the last decade there has been a tendency towards simplification of the surgical and restorative procedure. Shortening the time frame between implant installation and functional loading has been an important evolution in clinical practice, hence, lowering the barrier for the patient to go for an implant procedure. The first step has been to modify the surgical

<table>
<thead>
<tr>
<th>Implants Installed</th>
<th>Implants Lost</th>
<th>Survival %</th>
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<tbody>
<tr>
<td>CJ 1 stage</td>
<td>557 (114)</td>
<td>19 (11)</td>
</tr>
<tr>
<td>CJ 2 stage</td>
<td>211 (42)</td>
<td>5 (4)</td>
</tr>
<tr>
<td>PJ 1 stage</td>
<td>287 (122)</td>
<td>27 (22)</td>
</tr>
<tr>
<td>PJ 2 stage</td>
<td>150 (68)</td>
<td>17 (10)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1,205 (346)</td>
<td>68 (47)</td>
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A 50-year-old female patient had a removable prosthesis to replace the posterior teeth. The prosthesis provoked continuous pain due to pressure on the mental foramen, which was situated on top of the alveolar crest. This extreme bone resorption was caused by the ill-fitting denture and the young age of the patient at the time of teeth extractions. The alveolar height was insufficient to place implants posterior to the mental foramen and a new removable prosthesis was contra-indicated because of the superficial located mental foramen (Figures 1a & 1b). It was decided to remove the anterior teeth, although in good periodontal condition, and to install four standard Brånemark implants of 13 mm (Figure 1c). Extraction of the remaining teeth and installation of the implants were done simultaneously. The alveolar process was lowered and the harvested bone was collected to fill up the space between the implants and the alveolar bone. No bone substitutes or bone guided membranes were used (Figure 1d). The flaps were meticulously sutured around the healing abutments (Figure 1e). The patient was instructed not to wear her lower dentures and to leave out the upper prosthesis during the night to avoid pressure and non-functional load on the abutments. After three months, a fixed 12-unit bridge was mounted on the implants (Figure 1f). Occlusion was provided on the anterior teeth as well as on the posterior extensions to spread the occlusal forces equally to all implants. Comparison of the radiological images after one year and after five years shows stable bone height, perfectly filled extraction sockets and good osseointegration of the implants (Figures 1g & 1h).
treated in the two-stage group were heavy smokers, bruxists, patients with a small interarch distance and patients who wanted to wear their denture day and night. The patients treated in the one-stage groups were advised to refrain from wearing dentures as much as possible during the three month healing period. This was no problem for the partially edentulous patients, since most implants were installed in premolar/molar areas where the aesthetic consequences of having no teeth were less important than in the anterior region. In case the patient wanted to keep the full lower jaw denture during the healing period, care was taken to remove pressure from the saddle part onto the abutments. The removable dentures were relined meticulously and patients were advised not to wear the denture during the night to avoid overloading. The patients were checked every other two to four weeks to adjust the denture or to tighten the healing abutments, which have the tendency to unscrew.

In total, 346 referred patients were treated with 1,205 machined surface Brånemark implants of various length, design and width. All implants were in function for at least four years and the total survival rate was 94%, which is in agreement with other clinical studies (Adell et al, 1981; Zarb & Schmitt, 1990; Nevins & Langer, 1993; Jemt & Lekholm, 1993). There was no statistical difference between the one and two-stage approach for anterior or posterior regions. Bone-to-implant contact was comparable between the two techniques as seen in Table 2 and in line with the bone remodelling data described previously (Adell et al, 1981; Zarb & Schmitt, 1990; Jemt & Lekholm, 1993; Collaert & De Bruyn, 1998; Ericsson et al, 2000) and a steady-state was established after one year of loading with no further statistically significant differences up to three and five years of loading (Table 2). Case Report 3 shows radiographic bone remodelling around a partial implant case during the five-year follow-up.

It can be concluded from the presented literature and the clinical data that the classical two-stage surgical approach with Brånemark implants has evolved during the last few years into a one-stage approach, at least in the mandible, without jeopardising the clinical outcome. In the aforementioned studies, however, a three to four month healing period was respected during which the implants were non-functionally loaded, with no direct occlusion or articulation with the

Figure 1e: The flaps were meticulously sutured around the healing abutments

Figure 1f: After three months, a fixed 12-unit bridge was mounted on the implants. This bridge consists of 12 acrylic teeth that are chemically and mechanically bonded on a gold/palladium superstructure. Bone remodelling after extrarction caused recession around the abutments

Figure 1g: Radiological image of the implants which are osseointegrated in the alveolar bone. The alveolae are filled with bone after one year in function

Figure 1h: Radiological image after five years: bone height remains stable around the implants
CASE REPORT 2: PATIENT WITH MISSING MOLARS ON THE RIGHT SIDE OF THE LOWER JAW

This 35-year old female patient presented with a combined endodontic and periodontal problem on tooth $7\rangle$. It was decided to extract $7\rangle$ and to perform a curettage of the bone to remove the osteitis and promote a good bone healing. During the same surgery the root of a previous extracted $6\rangle$ was removed. Three months after extraction, two wide platform (5mm diameter) Brånemark implants were installed in a single stage surgery. The implants were initially completely surrounded with bone and only the external hex of the implant was supracrestal. Two healing abutments were placed which were not in contact with the antagonists but high enough to avoid gingival overgrowth. After four months the healing abutments were replaced with multi-unit abutments and the referring dentist started the prosthetic work. Radiographical images after one year show bone remodeling and resorption to the first thread of the implant, which is a normal finding reflecting the establishment of a biological width. This situation remained stable up to seven years of functional loading.

Figure 2a: Radiological image shows apical lesion on tooth $7\rangle$. There is enough alveolar bone height to install implants above the mandibular nerve.

Figure 2b: Two Brånemark wide platform implants are installed on $6\rangle$ and $7\rangle$ in a single-stage procedure. Healing abutments are placed immediately after surgery.

Figure 2c: Three months after implant surgery: the implants seem to be clinically osseointegrated and uneventful healing of the gingival tissues took place.

Figure 2d: Installation of the final abutments.

Figure 2e: Radiographical image one year after functional loading.

Figure 2f: Clinical image one year after functional loading. Note calculus on teeth $6\rangle$ and $7\rangle$.

Figure 2g: Radiographical image seven years after functional loading.
CASE REPORT 3: RADIOLOGICAL CHANGES IN A PARTIAL CASE DURING FIVE YEARS OF FOLLOW-UP

This case represents the first partial patient treated with one-stage approach. Three short (7-10mm) machined surface Brånemark implants were installed in the left mandible replacing $\text{F56}$.

Figure 3a: Radiographical image of the implants with healing abutments immediately after surgery. Short healing abutments were placed to avoid direct loading with the antagonistic teeth.

Figure 3b: Radiographical image of the implants five months after surgery and immediately after bridge connection. Bone remodeling up to the first implant thread has taken place.

Figure 3c: Radiographical image after five years of functional loading shows that no further bone loss occurred.

From first stage to early loading

Early loading means that the antagonistic teeth. This waiting time can sometimes lead to some complications and implant failures, especially attributed to overloading of single standing short (<13 mm long) fixtures as seen in Case Report 4. Rigid provisional connection of the implants can minimise the risk for premature overloading as shown in Figure 5. However, in the completely edentulous mandible it is recommended to start with the prosthetic procedure immediately after surgery to overcome these clinical problems.

From first stage to early loading

Early loading means that the implants are installed with a one-stage approach and functionally loaded within four weeks. There is sufficient evidence for good clinical results on machined surface Brånemark implants installed in the anterior mandible. Schnitman et al (1997) have published 10-year results of one-stage immediately loaded implants in 10 patients and reported 15% failure of these implants compared to no failures with a two-stage surgery and loading after a healing period of three to four months. However, the lost implants were only 10mm long and supported extensive restorations. Randow et al (1999) have treated 16 completely edentulous mandibles using a one-stage procedure and early loading within three weeks with a fixed rigid prosthetic reconstruction on live to six implants. In comparison with a control group of 11 patients treated with the conventional two-stage procedure and loading after four months, they reported similar results regarding implant success and bone-to-implant adaptation after 18-36 months. No further complications occurred over a five years period of loading and bone resorption was found to be within the same range in both procedures (Ericsson et al, 2000). Malo et al (2000) have recently shown 96% of implant survival in a study whereby partial bridgework in the aesthetic zone of both maxilla and mandible was loaded with a provisional prosthesis immediately after implant surgery. The prostheses were free of occlusion and articulation for five months and then replaced by the final restoration. They reported a small number of complications, however, not differing in character from those normally encountered with conventional implant treatment.

Clinical study on early implant loading in completely edentulous mandibles

From October 1997 to October

<table>
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<th>TABLE 2</th>
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<td>Average bone remodeling around machined surface Brånemark implants installed in the mandible in 1- or 2- stage procedure. Complete jaw bridges on 4-6 implants (CJ) and partial restorations (PJ) on 1-4 implants in premolar-molar area. Comparative measurements on 10 consecutively treated patients up to 5 years in function.</td>
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<tr>
<td>---------</td>
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<tr>
<td>0-1 year</td>
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<tr>
<td>CJ Stage 1</td>
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<tr>
<td>CJ Stage 2</td>
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<tr>
<td>PJ Stage 1</td>
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<tr>
<td>PJ Stage 2</td>
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This is a failure case showing the effect of unwanted premature loading on short fixtures installed in first stage surgery but with delayed loading time. The patient waited more than six months after implant installation before consulting the referring dentist for prosthetic treatment. During this time teeth clenching or grinding has led to extreme bone loss on the short fixture but not on the neighbouring long implants.

Figure 4a: Six months after surgery (June 1996) the short implant showed pronounced bone loss but without clinical signs of infection. Because the patient refused to have the implant removed, it was connected to a provisional bridge, but kept out of functional loading.

Figure 4b: 10 months later (May 1997) the bone to implant adaptation remained stable and a final bridge was made with occlusal loading.

Figure 4c: Eight months after functional loading (January 1998) further bone loss was seen.

Figure 4d: Another 10 months (October 1998) later the implant completely exfoliated and removed.

2001, 30 patients (15 men, 15 women, between the ages of 63 to 81) were consecutively operated upon. All patients were completely edentulous in the mandible for at least two months. They were medically healthy and smoking was not an exclusion criterion. Prior to treatment, periodontal therapy on any remaining natural teeth in the maxilla was performed, including optimisation of oral hygiene. In total, 153 machined surface (non-roughened) titanium implants (Nobel Biocare, Gothenburg Sweden) of various lengths (7-18mm), widths (3.75-5.0mm) of screw design (standard, MK II, MK III, MK IV) were inserted. The 3.75mm diameter implant was the first choice implant but in 15% of the sites wider 4mm or 5mm implants were needed to obtain optimal initial stability. An insertion torque value of 40Ncm was considered a prerequisite for immediate loading. Implants were positioned predominantly between the mental foraminae and only nine implants (five patients) were positioned posterior to the mental foramen. Abutments of various types were connected immediately after implant installation and an impression was taken either immediately or within one week at the time of suture removal. The prosthetic treatment was carried out by the referring dentists and finished on average 18 days after surgery. The majority of the prostheses were of the typical Bränemark bridge design with 1.5-2 cm long cantilevers posterior to the most distally located implant. Opposing dentures, when present, were renewed or remounted. Implant stability was checked clinically after removal of the reconstruction after 12 and 24 months of loading. The prostheses were not removed routinely after this initial period. Periapical radiographs were taken with the long-cone technique immediately after prosthesis connection and further yearly.

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to assess bone to implant contact. In total, one out of 153 implants failed (0.7%) after 13 weeks of functional loading but this had no impact on prosthetic success (100%). The average bone to implant adaptation values (1.4 ± 0.5mm after three years) reflected a normal bone remodelling during function, which remained stable after the first year. Bone remodelling is a normal biological phenomenon related to healing of the peri-implant tissues after piercing the gingival tissues. A case report from this study is shown in Figure 6.

Figure 5: Fixed metal-reinforced acrylic splint connecting the five implants rigidly in order to avoid overloading of the single-standing fixtures. After three months' damage and abrasion of the splints gives an idea of the heavy occlusal forces without damaging osseointegration.

Early loading of a fixed jaw anchored restoration on four to six machined surface Brånemark implants in completely edentulous mandibular bone is a predictable treatment option. This success rate is in accordance with other studies using the same approach and the same implants (Randow et al, 1999; De Bruyn & Colaert, 2002; Becker et al, 2003) and comparable with the classical two-stage delayed treatment protocol.

References


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Q1: The original Brånemark protocol advocated implant installation in how many stages?
- a) One
- b) Two
- c) Three
- d) Four

Q2: According to Adell et al (1981), what healing time was postulated for implants in the maxilla?
- a) Three months
- b) Six months
- c) Nine months
- d) One year

Q3: In the authors’ clinical study, what was the total survival rate for the implants placed?
- a) 82%
- b) 88%
- c) 94%
- d) 100%

Q4: Schnitman et al reported what level of failure in one-stage immediately loaded implants in 10 patients?
- a) 0%
- b) 5%
- c) 10%
- d) 15%

Q5: A prerequisite for immediate loading is an insertion torque value of:
- a) 40Ncm
- b) 50Ncm
- c) 60Ncm
- d) 70Ncm