

# Provisional Implants: A Clinical Prospective Study in 45 Patients, from Implant Placement to Delivery of the Final Bridge

Pär-Olov Östman, DDS;\* Mats Hellman, DDS;\* Hans Nilson, DDS;† Ingvar Ericsson, DDS, Odont PhD‡

---

## ABSTRACT

*Background:* Protocols for submerged healing of dental implants often require the patient to have no teeth until suture removal and to wear a removable prosthesis during the remaining healing period. This may be inconvenient for the patient, and healing may be influenced negatively by the removable prosthesis.

*Purpose:* The aim of the present prospective clinical study was to evaluate the use of provisional implants (PIs) to provide patients with a provisional fixed bridge during the healing of permanent implants.

*Materials and Methods:* Twenty female and 25 male patients were consecutively included in the study. The 45 patients were treated for either partial (16 patients) or total (29 patients) edentulism in the maxilla. The permanent implants were placed first; as many PIs as possible were then installed between the permanent implants. After suturing, impressions from which to manufacture provisional bridges (to be cemented to the PIs) were taken. The patients were monitored with clinical and radiographic follow-up from implant placement to delivery of the final prosthesis.

*Results:* Five (2.2%) of the 230 permanent Brånemark System® implants (Nobel Biocare AB, Gothenburg, Sweden) did not integrate. None of the failures could be related to the presence of PIs between the permanent implants. Seven PIs failed during the observation period. In addition, 17 (9%) of the 192 PIs showed mobility at the second-stage surgery although they had supported the provisional bridges without clinical symptoms. Forty-four of 45 patients showed stable PI bridges at the time of second-stage surgery.

*Conclusion:* Based on our experiences we concluded that provisional implants can be successfully used to provide patients with a fixed provisional bridge during the healing of permanent implants.

**KEY WORDS:** clinical study, dental implants, immediate loading, provisional implants

---

Titanium dental implants are routinely and successfully used as abutments for fixed partial dentures (FPDs) in edentulous<sup>1-8</sup> as well as partially dentate jaws.<sup>9-14</sup> Relevant studies have been based on the use of the traditional two-stage surgical protocol, implying connection of the abutment at a second surgical session 3 to 6 months following the placement of the fixtures in a submerged position.

---

\*Private clinic, Falun, Sweden, and Department of Biomaterials, Institute for Surgical Sciences, Sahlgrenska Academy, Gothenburg University, Gothenburg, Sweden; †Department of Prosthetic Dentistry, Faculty of Odontology, Umeå University, Umeå, Sweden; ‡Department of Prosthetic Dentistry, Faculty of Odontology, Malmö University, Malmö, Sweden

Reprint requests: Pär-Olov Östman, Holmgatan 30, S-791 71 Falun, Sweden; e-mail: po.ostman@telia.com

©2004 BC Decker Inc

The use of screw-shaped titanium implants (ad modum Brånemark System®, Nobel Biocare AB, Gothenburg, Sweden) is looked upon as the “gold standard” because of the extensive documentation and the good results reported. The good results achieved with the original two-stage surgical protocol for implant installation has resulted in the reevaluation and further development of the technique.

Schroeder and colleagues<sup>15-17</sup> demonstrated the possibility of achieving osseointegration without submerging the fixtures. Several research teams<sup>18-21</sup> have reported experimental data on the use of one-piece implant pillars, confirming the observations presented by Schroeder and colleagues. Similar observations from a dog model using the two-piece implants placed in a one-stage surgical procedure have been reported.<sup>21,22</sup> Furthermore, during the last decade there have been

published reports demonstrating successful clinical treatment results with the one-stage surgical protocol with Brånemark System fixtures.<sup>23-29</sup>

The degree of micromotion at the bone-implant interface has been argued to influence the implant integration process. According to some authors it is the absence of micromotion at the bone-implant interface during the initial healing phase that is of great importance for osseointegration rather than the early loading as such.<sup>30-33</sup> Cameron and colleagues<sup>34</sup> found that micromotion amounting to about 200  $\mu\text{m}$  at the bone-implant interface results in the formation of fibrous tissue, thus preventing osseointegration. The implant's surface characteristics are also of importance. According to Søballe and colleagues<sup>35</sup> the tolerated micromotion for roughened implant surfaces is 50 to 150  $\mu\text{m}$ . Brunski<sup>36</sup> proposed that a 100  $\mu\text{m}$  micromotion is the threshold level for the turned surface. According to Glantz and colleagues<sup>37,38</sup> favorable loading conditions are achieved via a rigid FPD. Therefore it could be argued that good treatment results can be reached provided that a rigid FPD is connected to the implants as soon as possible after fixture placement. In other words, the implants will be rigidly splinted to each other via the FPD, thus decreasing the micromotion at the bone-implant interface, which in turn will facilitate proper osseointegration.

Provisional or temporary implants can be used to provide patients with a fixed temporary reconstruction during the healing period of the submerged fixtures. As early as 1970 a provisional implant in the form of the Lew Screw was introduced.<sup>39</sup> Some years later other types of provisional implants were described, such as the Sendax Mini Dental Implant® (IMTEC Corporation, Ardmore, OK, USA) and the Dentatus implant system (Dentatus AB, Stockholm, Sweden).<sup>40</sup> Different clinical techniques using temporary implants have been presented mainly in case reports at courses and conferences. The use of temporary implants is short term; the lack of follow-up studies is easy to understand. However, the classic study in this respect is the study presented by Schnitman and colleagues,<sup>41,42</sup> who used ordinary "extra" implants to support a provisional FPD during the healing period of the submerged fixtures. The survival rate of these "additional" implants was reported to be about 85%.

The introduction of the Immediate Provisional Implant® system (Nobel Biocare AB) has reawakened

interest in provisional and temporary implants. Also, the knowledge obtained during the last decade regarding the immediate and early function of implants has increased interest in provisional and temporary implants and their use. The surgical and prosthetic technique has been described by Schuppan<sup>43</sup> and Babbush.<sup>40</sup> Schuppan claims that "the use of temporary implants has no adverse effects on the host implants" and concludes that "based on 550 patients treated with temporary implants, the significant advantages of this treatment modality are clearly evident."<sup>43</sup> Babbush presents 12 cases with a total of 53 provisional implants; only one PI had to be removed before planned.<sup>40</sup>

The aim of the present prospective clinical study was to evaluate the use of provisional implants (PIs) to provide patients with a provisional fixed bridge during the healing of permanent implants.

## MATERIALS AND METHODS

Twenty female and 25 male patients were included in the study. The 45 patients were treated either for partial (19 patients) or totally (26 patients) edentulous maxillas. The age and gender distribution of the patients is presented in Table 1. The presurgical evaluation included clinical and radiographic (periapical radiography as well as orthopantomography) examinations. All 45 patients were informed about the study design and consented to participate.

### Surgery and Implants

About 1 hour prior to surgery, the patients were given 3 g of amoxicillin (Amimox®, Tika Läkemedel AB, Lund, Sweden) and diazepam (Stesolid®, Alparma, Stockholm, Sweden) (0.3 mg/kg body weight) orally. Infiltration anesthesia (Xylocaine®-Adrenaline, AstraZeneca, Södertälje, Sweden) was used.

TABLE 1 Patient Age\* and Gender Distribution

Age	Male	Female	Total
41-50	1	1	2
51-60	7	5	12
61-70	8	6	14
71-80	8	7	15
81-	1	1	2
Total	25	20	45

\*Average age, 67.1 years; range, 45 to 91 years.

The alveolar process was exposed by elevating the mucoperiosteal flaps. In edentulous maxillas five to seven Brånemark System implants were placed; in partially edentulous situations two to four implants were placed. The fixtures had either turned or TiUnite™ (Nobel Biocare AB) surfaces. The main part of the permanent implants that were installed was 13 mm or longer and of regular platform (RP) type (Tables 2 and 3). The quality and quantity of the bone were classified according to the Lekholm and Zarb classification<sup>44</sup> (Table 4). After placement of the permanent implants, PIs (Nobel Biocare AB) were placed between the permanent implants (Figure 1). In brief, the PI is a one-piece implant with a bendable neck to which a provisional bridge can be cemented (Figure 2). The diameter is 2.8 mm; the threaded part is 14 mm long and is supplied with a turned surface. The site is prepared with a 1.5 mm twist drill, and the self-tapping PI is placed. In the present study as many PIs as possible were placed at a distance of 2 to 3 mm to the permanent implants (Figure 3). A special effort was made to find dense bone. In types I and II bone<sup>44</sup> the full length of the twist drill was used whereas in bone of quality levels 3 to 4,<sup>44</sup> only a 5- to 7 mm-deep entrance was prepared. The PIs were then inserted to full depth. Before adaptation and suturing of the flaps, the angulation of the PIs was checked, and necessary adjustments were performed by bending (Figure 4). The total number of permanent implants placed was 145; the corresponding figure for the PIs was 121. The most common condition found was C3 bone. The minimum number of permanent implants placed was 2, and the maximum number was 7. The corresponding respective figures for PIs were 2 and 8.

**Prosthetic Procedures and Follow-Up Examinations**

After the surgical session and after suturing, copings were placed on the PIs (Figure 5), and a quick-setting high-viscosity polyvinyl siloxane (Dimension™ Penta™ H Quick, 3M ESPE, St. Paul, MN, USA) impression was

**TABLE 2 Surface of the Permanent Implants**

Implant, Surface	NP	RP	WP	Total
Mk III, turned	8	31	1	40
Mk IV, turned	—	22	—	22
Mk III, TiUnite	19	147	2	168

NP = narrow platform; RP = regular platform; WP = wide platform.

**TABLE 3 Length and Platform of Permanent Implants**

Length (mm)	NP	RP	WP	Total
10.0	2	3	—	5
11.5	—	2	2	4
13.0	8	22	1	31
15.0	17	112	—	129
18.0	—	61	—	61
Total	27	200	3	230

NP = narrow platform; RP = regular platform; WP = wide platform.

taken of the upper jaw, with the copings embedded in the impression. Bite registration (with any suitable material) was performed, and a traditional impression of the opposing jaw was taken.

The provisional FPD was most commonly fabricated with an indirect technique, that is, the existing removable denture was rebuilt in such a way that it could be cemented to the PIs or to the tooth or teeth included as abutments in the provisional fixed bridge (Figures 6–9). No cantilever units exceeding 5 mm were accepted. The first choice of cement was a temporary one (eg, ImProve™, Nobel Biocare AB). (In Figures 7 to 9 some patients are presented wearing the provisional FPD.)

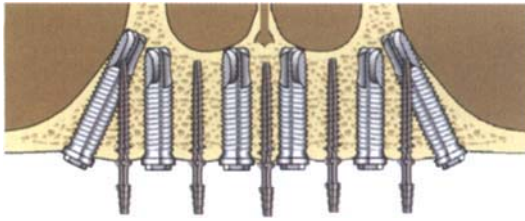
All patients participating in the study agreed to be enrolled in a strict and individually designed maintenance care program focusing on the following:

1. Oral hygiene instructions
2. Stability of the provisional FPD
3. Condition of the soft tissues
4. Careful examinations focusing on probable complications and how to remedy them without jeopardizing the permanent implants

**TABLE 4 Bone Quality and Quantity Distribution\***

Bone Quality	Bone Quantity				Total
	A	B	C	D	
1	—	—	—	—	0
2	—	3	1	3	7
3	1	10	15	—	26
4	1	8	1	2	12
Total	2	21	17	5	45

\*Adapted from Lekholm and Zarb.<sup>44</sup>



**Figure 1** Following placement of the permanent implants, provisional implants are placed between them.



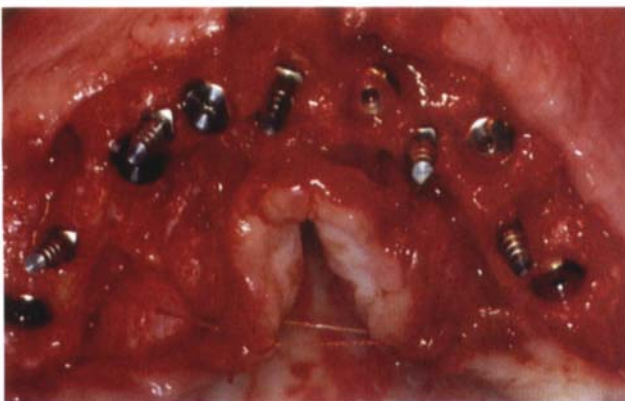
**Figure 2** The Immediate Provisional Implant is a one-piece implant with a bendable neck.

### Second-Stage Surgery

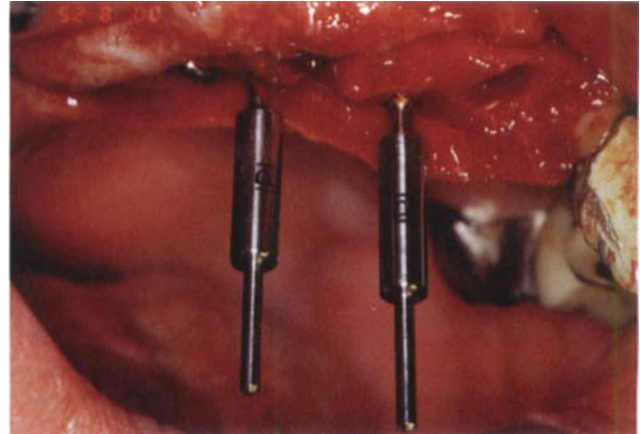
Six months after initial implant placement, mucoperiosteal flaps were raised to enable proper abutment connection according to the original protocol. At the same session, all or some of the PIs were removed by rotating them anticlockwise with the insertion tool mounted on the torque device (Figure 10). In situations when not all PIs were removed, the remaining ones served as abutments for the provisional FPD during the fabrication of the permanent FPD. At the latest, the remaining PIs were removed when it was time to connect the permanent FPD to the permanent implants.

### RESULTS

Five (2.2%) of the 230 permanent Brånemark implants placed did not integrate and were subsequently removed at the second-stage surgery. Seven (3.6%) PIs failed owing to infection or pain during the observation period and were removed. Seventeen (9%) of 192 PIs placed showed mobility at the second-stage surgery



**Figure 3** Clinical photograph taken after installation of permanent and provisional implants. The space between the different implants should be 2 to 3 mm.



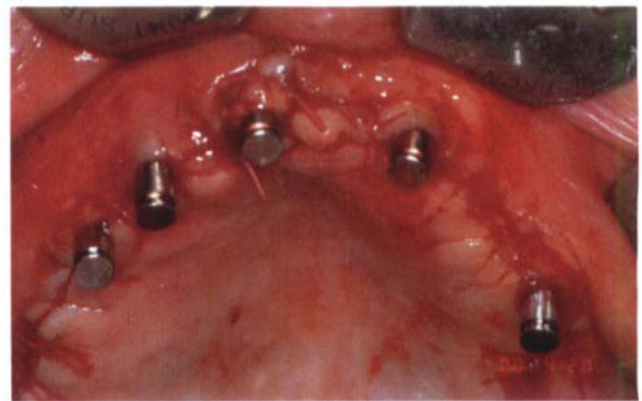
**Figure 4** Before adaptation and suturing of the flaps, the angulations of the PIs are adjusted by bending.

although they had served as support for the provisional bridge without clinical symptoms. All the mobile PIs had been placed in bone of qualities 3 and 4. Forty-seven PIs were removed at the second-stage surgery, and 138 were removed at permanent bridge delivery.

Forty-four of 45 patients had stable provisional fixed bridges at the time of the second-stage surgery. In one patient the provisional fixed bridge was removed after 10 weeks because of pain and mobility. In this case the permanent implants were loaded with a fixed temporary bridge during the remaining 3-month period until fabrication of the permanent bridge. One provisional fixed bridge was fractured during the observation interval; it was mended and functioned well throughout the observation period.

### DISCUSSION

The present clinical study clearly demonstrated that PIs can be successfully used to provide patients with a fixed



**Figure 5** Impression copings mounted in the temporary implants. The same copings are used as retention elements in the final provisional implant bridge.



**Figure 6** Two views of a removable denture rebuilt by the dental laboratory in such a way that it can be cemented to the provisional implants. The copings are embedded in the acrylic as retention elements.

provisional bridge during the healing of permanent implants. Forty-four of 45 FPDs supported by PIs maintained their stability during the healing phase of at least 6 months. Both partially and totally dentate jaws were included. In the partially dentate situations some of the neighboring teeth were sometimes used. The integration of teeth in the provisional FPDs not only increased the number of abutments but also protected the provisional FPD from lateral forces.

The failure cases were (1) a partially dentate patient with soft bone (types 3 and 4) who showed signs of bruxism and (2) a totally dentate patient with severe bruxism (she was provided with a nightguard but never used it). Bruxism is most likely one of the contraindications for applying temporary occlusal rehabilitation by means of PIs.

The five permanent implants that did not integrate had machined (turned) surfaces and had been placed in type 3 and 4 bone. Soft bone will most likely result in a lesser initial implant stability. This has been pointed out as a main reason for implant failure.<sup>45-47</sup>

Jaffin and Berman<sup>45</sup> reported a failure rate of 44% for implants placed in type 4 bone. The corresponding figure for implants placed in bone of types 1, 2, and 3 was only 3.6%. The TiUnite surface seems, at least in type 4 bone, to be more beneficial than the machined one.<sup>48,49</sup> This observation is in agreement with previously reported experimental data.<sup>50</sup> Zechner and colleagues<sup>50</sup> compared bone-to-implant contact at three different implant surfaces on "Brånemark bodies" in minipigs. The authors reported a bone-to-implant contact of about 20% at the machined surface. The corresponding figure for the TiUnite surface was 43%. Furthermore, the survival rate (97.8%) of the permanent implants in the present study is in line with short-term data reported earlier.<sup>51</sup> No clinical signs could be observed, indicating that the implant failures were related to the use of PIs.

Only 7 of 192 PIs were lost during the observation period, but 17 were not stable at the time for second-stage surgery. Nevertheless these unstable PIs had obviously contributed to the support of the provi-



**Figure 7** A rebuilt removable denture fitted in a patient. The provisional implant bridge has an extension from 15 to 25 and is supported by five provisional implants.



**Figure 8** A partial denture rebuilt to a provisional implant bridge. Tooth 13 is integrated in the construction. Extension is from 13 to 25; support is by three provisional implants.



**Figure 9** A provisional implant bridge made by composite: a mixture of provisional implants (15 to 21) and teeth (22 to 25).

sional FPD. Krennmair and colleagues<sup>52</sup> reported a failure rate of 36.2% for maxillary temporary implants. However, in their study the temporary implants were loaded with an overdenture and were not splinted with a fixed bridge. An advantage of using PIs in combination with fixed temporary bridges is that the load meeting the permanent submerged implants will be minimized, thus perhaps increasing the success rate of these implants. A side observation made at the second-stage surgery was the excellent condition of the covering mucosa, namely, thin (nonhyperplastic) and with minimal signs of irritation. Whether this condition can be related to the fact that no removable provisional dentures were used is only to be speculated upon. Controlled clinical trials are needed to confirm such a hypothesis.

## CONCLUSIONS

Within the limitations of the present clinical study, the following conclusions could be postulated:



**Figure 10** The provisional implants were removed by rotating them anticlockwise with the insertion tool mounted on the torque device.

1. PIs can predictably be used to provide patients with a fixed provisional bridge during healing of permanent implants.
2. No interference with the osseointegration process of the permanent submerged implants owing to the placement of PIs could be observed.
3. Although some PIs were found to be mobile at abutment connection, they had supported the provisional bridge asymptotically.

## ACKNOWLEDGMENT

The investigators express their thanks to Nobel Biocare Norden AB, Gothenburg, Sweden, for excellent statistical support, and to dental hygienist Gun Johansson, for taking care of the maintenance of the patients participating in the present study.

## REFERENCES

1. Albrektsson T, Zarb G, Worthington P, et al. The long-term efficacy of currently used dental implants: a review and proposed criteria of success. *Int J Oral Maxillofac Implants* 1986; 1:11–25.
2. Adell R, Eriksson B, Lekholm U, et al. A long-term follow-up study of osseointegrated implants in the treatment of totally edentulous jaws. *Int J Oral Maxillofac Implants* 1990; 5:347–359.
3. Albrektsson T. On long-term maintenance of the osseointegrated response. *Austr Prosthodont J* 1993; 7:15–24.
4. Arvidson K, Bystedt H, Frykholm A, et al. Five-year follow-up report of the Astra Dental Implant system for restoration of edentulous upper jaws. *J Dent Res* 1996; 75:349. (Abstr)
5. Arvidson K, Bystedt H, Frykholm A, et al. Five-year prospective follow-up report of the Astra Tech Dental Implant System in the treatment of edentulous mandibles. *Clin Oral Implants Res* 1998; 9:225–234.
6. Jemt T, Lekholm U. Oral implant treatment in posterior partially edentulous jaws: a 5-year follow-up report. *Int J Oral Maxillofac Implants* 1995; 10:635–640.
7. Lindquist LW, Carlsson GE, Jemt T. A prospective 15-year follow-up study of mandibular fixed prostheses supported by osseointegrated implants. *Clin Oral Implants Res* 1996; 7:627–635.
8. Makkonen TA, Holmberg S, Niemi L, et al. A 5-year prospective clinical study of Astra Tech dental implants supporting fixed bridges or overdentures in the edentulous mandible. *Clin Oral Implants Res* 1997; 8:469–475.
9. Van Steenberghe D. A retrospective multicenter evaluation of the survival rate of osseointegrated fixtures supporting fixed partial prosthesis in the treatment of partial edentulism. *J Prosthet Dent* 1989; 61:217–222.
10. Henry P, Laney WR, Jemt T, et al. Osseointegrated implants for single-tooth replacement: a prospective 5-year multi-

- center study. *Int J Oral Maxillofac Implants* 1996; 11: 450–455.
11. Lekholm U, van Steenberghe D, Herrman I, et al. Osseointegrated implants in the treatment of partially edentulous jaws: a prospective 5-year multicenter study. *Int J Oral Maxillofac Implants* 1994; 9:627–635.
  12. Lekholm U, Gunne J, Henry P, et al. Survival of the Brånemark implant in partially edentulous jaws: a 10-year prospective multicenter study. *Int J Oral Maxillofac Implants* 1999; 14:639–645.
  13. Palmer RM, Smith BJ, Palmer PJ, et al. A prospective study on Astra single tooth implants. *Clin Oral Implants Res* 1997; 8:173–179.
  14. Scheller H, Urgell JP, Kultje C, et al. A 5-year multicenter study on implant-supported single crown restorations. *Int J Oral Maxillofac Implants* 1998; 13:212–218.
  15. Schroeder A, Pohler O, Sutter F. Gewebsreaktion auf ein Titan-Hohlzylinder-Implantat mit Titan-Spritz-schichtoberfläche. *Schweiz Monatsschr Zahnheilkd* 1976; 86:713–727.
  16. Schroeder A, Stich H, Straumann F, Sutter F. Über die Anlagerung Osteocement an einem belasteten Implantat-körper. *Schweiz Monatsschr Zahnheilkd* 1978; 88:1051–1058.
  17. Schroeder A, Maeglin B, Sutter F. Das ITI-Hohlzylinderimplantat Typ F zur Prothesenretention beim zahnlosen Kiefer. *Schweiz Monatsschr Zahnheilkd* 1983; 93:720–733.
  18. Gotfredsen K, Rostrup E, Hjørting-Hansen E, Stoltze K, Budtz-Jørgensen E. Histological and histomorphometrical evaluation of tissue reactions adjacent to endosteal implants in monkeys. *Clin Oral Implants Res* 1991; 2:30–37.
  19. Piatelli A, Paoloantonio M, Corigliano M, Scarano A. Bone reactions to early occlusal loading of two-stage titanium plasma-sprayed implants. A pilot study in monkey. *Int J Periodontics Restorative Dent* 1997; 17:163–169.
  20. Weber H-P, Buser D, Donath K, Fiorellini JP. Comparison of healed tissues adjacent to submerged and non-submerged unloaded titanium dental implants. A histomorphometric study in beagle dogs. *Clin Oral Implants Res* 1996; 7:11–19.
  21. Abrahamsson I, Berglundh T, Wennström J, Lindhe J. The peri-implant hard and soft tissues at different implant systems. A comparative study in the dog. *Clin Oral Implants Res* 1996; 7:212–219.
  22. Ericsson I, Nilner K, Klinge B, Glantz P-O. Radiographical and histological characteristics of submerged and non-submerged titanium implants. An experimental study in the Labrador dog. *Clin Oral Implants Res* 1996; 6:20–26.
  23. Ericsson I, Randow K, Glantz P-O, et al. Some clinical and radiographical features of submerged and non-submerged titanium implants. *Clin Oral Implants Res* 1994; 5:185–189.
  24. Ericsson I, Randow K, Nilner K, et al. Some clinical and radiographical features of submerged and non-submerged titanium implants. A 5-year follow-up study. *Clin Oral Implants Res* 1997; 8:422–426.
  25. Henry P, Rosenberg J. Single-stage surgery for rehabilitation of the edentulous mandible. Preliminary results. *Pract Periodontics Aesthet Dent* 1994; 6:1–8.
  26. Bernard J-P, Belser UC, Martinet J-P, et al. Osseointegration of Brånemark fixtures using a single-step operating technique. A preliminary prospective one-year study in the edentulous mandible. *Clin Oral Implants Res* 1995; 6:122–129.
  27. Becker W, Becker BE, Israelson H, et al. One-step surgical placement of Brånemark implants: a prospective clinical multicenter study. *Int J Oral Maxillofac Implants* 1997; 12:454–462.
  28. Collaert B, De Bruyn H. Comparison of Brånemark fixture integration and short-term survival using one-stage or two-stage surgery in completely and partially edentulous mandibles. *Clin Oral Implants Res* 1998; 9:131–135.
  29. Friberg B, Sennerby L, Lindén B, et al. Stability measurements of one-stage Brånemark implants during healing in mandibles. A clinical resonance frequency analysis study. *Int J Oral Maxillofac Surg* 1999; 28:266–272.
  30. Pilliar RM. Quantitative evaluation of the effect of movement at a porous coated implant-bone interface. In: Davies EJ, ed. *The bone-biometrial interface*. Toronto: University of Toronto Press, 1991:380–387.
  31. Brunski JE. Biomechanical factors affecting the bone-dental implant interface. *Clin Mater* 1992; 3:153–201.
  32. Brunski JE. In vivo bone response to biomechanical loading at the bone/dental implant interface. *Adv Dent Res* 1999; 13:99–119.
  33. Szmukler-Moncler S, Salama H, Reingewirtz Y, Dubruille J-H. Timing of loading and effect of micro-motion on bone-implant interface: a review of experimental literature. *J Biomed Mater Res* 1998; 43:192–203.
  34. Cameron H, Pilliar RM, Macnab I. The effect of movement on the bonding of porous metal to bone. *J Biomed Mater Res* 1973; 7:301–311.
  35. Søballe K, Hansen ES, Brockstedt-Rasmussen H, Bünger C. The effects of osteoporosis, bone deficiency, bone grafting and micromotion on fixation of porous-coated hydroxyapatite-coated implants. In: Gesink RGT, Manley MT, eds. *Hydroxyapatite coatings in orthopaedic surgery*. New York: Raven Press:107–136.
  36. Brunski J. In vivo bone response to biomechanical loading at the bone/dental implant interface. *Adv Dent Res* 1999; 13:99–119.
  37. Glantz P-O, Strandman E, Svensson SA, et al. On functional strain in fixed mandibular reconstructions. I. An in vitro study. *Acta Odontol Scand* 1984; 42:241–249.
  38. Glantz P-O, Strandman E, Randow K. On functional strain in fixed mandibular reconstructions. II. An in vivo study. *Acta Odontol Scand* 1984; 42:269–276.
  39. Lew I. The endosseous implant: evaluations and modifications. *Dent Clin North Am* 1970; 14:201–213.
  40. Babbush CA. Provisional implants: surgical and prosthetic aspects. *Implant Dent* 2001; 10:113–119.
  41. Schnitman PA, Wöhrle PS, Rubenstein JE. Immediate fixed interim prostheses supported by two-stage threaded implants: methodology and results. *J Oral Implantol* 1990; 16:96–105.
  42. Schnitman PA, Wöhrle PS, Rubenstein JE, Da Silva JD, Wang N-H. Ten-year results for Brånemark implants

- immediately loaded with fixed prostheses at implant placement. *Int J Oral Maxillofac Implants* 1997; 12:495–503.
43. Schuppan K. Immediate provisional implant therapy. *Global Forum, Nobel Biocare International Newsletter* 2000; 13:7.
  44. Lekholm U, Zarb GA. Patient selection. In: Brånemark P-I, Zarb GA, Albrektsson T, eds. *Tissue integrated prostheses. Osseointegration in clinical dentistry*. Chicago: Quintessence, 1985:199–209.
  45. Jaffin RA, Berman CL. The excessive loss of Brånemark fixtures in type IV bone: a 5-year analysis. *J Periodontol* 1991; 62:2–4.
  46. Bahat O. Treatment planning and placement of implants in the posterior maxillae. *Int J Oral Maxillofac Implants* 1993;8:151–161.
  47. Bahat O. Brånemark System® implants in the posterior maxilla: clinical study of 660 implants followed 5–12 years. *Int J Oral Maxillofac Implants* 2000; 15:646–653.
  48. Glauser R, Portmann M, Ruhstaller P, Lundgren A-K, Hämmerle CHF, Gottlow J. Stability measurements of immediately loaded machined and oxidized implants in the posterior maxilla. A comparative clinical study using resonance frequency analysis. *Appl Osseointegration Res* 2001; 1:27–29.
  49. Friberg B, Billström C. Preliminary results of a prospective multicenter clinical study on TiUnite™ implants. *Appl Osseointegration Res* 2002; 3:29–31.
  50. Zechner W, Tangl S, Fürst G, et al. Osseous healing characteristics of three different implant types. A histologic and morphometric study in mini-pigs. *Clin Oral Implants Res* 2003; 14:150–157.
  51. Friberg B, Jemt T, Lekholm U. Early failures in 4,641 consecutively placed Brånemark dental implants. A study from stage 1 surgery to the connection of completed prosthesis. *Int J Oral Maxillofac Implants* 1991; 6:142–146.
  52. Krennmair G, Weinländer M, Schmidiner S. Provisional implants for anchoring removable interim prostheses in edentulous jaws: a clinical study. *Int J Oral Maxillofac Implants* 2003; 18:582–588.