# Fixed Partial Dentures Supported by Natural Teeth and Brånemark System Implants: A 3-year Report

Tore Tangerud, Cand Odont[1]/Arne Geir Grønningsæter, Cand Odont[2]/Åsa Taylor, DDS[3]

***Purpose:*** *To evaluate fixed partial dentures (FPDs) supported by a combination of natural teeth and implants in a variety of clinical situations.* ***Materials and Methods:*** *In 30 patients, 86 teeth and 85 implants were used as supports for 30 FPDs of varying extension (mean = 8.6 units); 23 in the maxilla and 7 in the mandible. The prostheses had a removable section fastened with screws to both the implants and to a section cemented on the supporting teeth, and were thus functioning as rigid, fixed partial dentures.* ***Results:*** *Five implants were lost prior to the placement of prostheses, 2 were lost after loading, giving survival rates of 91.0% in the maxilla and 95.5% in the mandible. Complications were predominantly soft tissue–related and were all amenable to treatments. One patient was lost to follow-up. The remaining 29 FPDs remained stable throughout the 3-year observation period.* ***Discussion:*** *Changes in plaque accumulated, bleeding on probing, pocket depths, and marginal bone level were acceptable. The survival rate of implants was comparable to that of similar studies. Further investigations are needed with regard to design for such FPDs.* ***Conclusion:*** *These findings, together with the patient satisfaction experienced, indicated that the combined support of implants and teeth for fixed prostheses may be appropriate treatment for patients.* (INT J ORAL MAXILLOFAC IMPLANTS 2002;17:212–219)

**Key words:** *combined tooth-implant support, dental implants, fixed partial dentures, mutually screw-retained prosthesis sections*

The difference in mobility between natural teeth and osseointegrated implants is a cause for concern when combining these units as abutments for fixed partial dentures (FPDs). It has been reported that the axial and transverse mobility of a natural tooth may be more than 10 times that of an endosseous implant.[1] Thus, if a fixed prosthesis is supported by 1 tooth and 1 implant, it may be acting as a cantilever off the implant-supported section, increasing the risk of overload on bone for the involved implant components and prosthesis. This risk, however, may be modified by the natural elasticity of bone, some resiliency in the component assemblies of supporting implants, and deflection in the supraconstruction itself.[2–4] Various forms of stress-breaking systems have otherwise been advanced to reduce the load on the supporting implants. In particular, resilient components may be interpositioned between each implant and the fixed prosthesis, or some prefabricated attachment may be utilized in the fixed prosthesis, allowing controlled mobility between components.

It has clearly been reported that rigid prostheses between a natural tooth and an implant may function very well over a long period of time,[5–7] seemingly without any negative consequences for the initially established implant osseointegration. Although this study was controlled (1 Brånemark implant was connected to 1 tooth in the mandible), there have been reports in the literature indicating that the potential for such FPDs may have a larger scope and may also involve other types of implants.[8–11]

The purpose of the present investigation was to evaluate FPDs with combined tooth and implant support in both the maxilla and mandible as well as in a variety of clinical situations. Parameters investigated included different FPD lengths and varying numbers of supporting units. Brånemark System implants (Nobel Biocare, Göteborg, Sweden) were utilized for this clinical study.

[1]Associate Professor (Retired), Institute of Odontology-Prosthodontics, Faculty of Dentistry, University of Bergen, Bergen, Norway.
[2]Assistant Professor, Institute of Odontology-Oral Surgery and Oral Medicine, Faculty of Dentistry, University of Bergen, Bergen, Norway.
[3]Chief Consultant, Nobel Biocare, Göteborg, Sweden.

**Reprint requests:** Dr Tore Tangerud, Calle Aladroc-Finca Marta no. 52, 03720 Benissa (Alicante), Spain. E-mail: tore.tangerud@wanadoo.es

**Table 1 Distribution of Implants, Teeth, and Restorations Related to Age, Gender, Jaw, and Prosthesis Type**

| | Supporting implants (85) | | | | Supporting teeth (86) | | | | Supraconstruction (30) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Maxilla | | Mandible | | Maxilla | | Mandible | | Maxilla | | Mandible | |
| Age group | F | M | F | M | F | M | F | M | Ceramic | Composite | Ceramic | Composite |
| 40–49 | 8 | 1 | — | — | 10 | 1 | — | — | 3 | 1 | — | — |
| 50–59 | 22 | — | 2 | 5 | 24 | — | 1 | 2 | 6 | 2 | — | 2 |
| 60–69 | 15 | 9 | 8 | — | 16 | 6 | 10 | — | 5 | 2 | 2 | 1 |
| 70–79 | — | 9 | — | — | — | 8 | — | — | — | 4 | — | — |
| 80–89 | — | — | — | 6 | — | — | — | 8 | — | — | — | 2 |
| Total | 64 | | 21 | | 65 | | 21 | | 23 | | 7 | |

F = female; M = male.

## MATERIALS AND METHODS

Thirty patients registered in the period of 1991 to 1994 were accepted for planned surgical and prosthodontic treatment at the Dental School, University of Bergen, Norway. These were selected among dentate individuals with diagnosed needs for prosthodontic treatment by use of the following criteria: *(1)* prominent requests for fixed prostheses where the extension desired was unattainable by conventional FPD; *(2)* conditions allowing placement of an adequate supplement of endosseous implants; *(3)* additional evaluation leading to the choice of FPDs supported by both natural teeth and implants, rather than separate restorations on individual teeth and implants. No restriction as to size or location for the planned FPDs was applied in this clinical investigation, other than consideration of the distribution of supporting elements for the fixed prostheses. Tooth extractions in the relevant areas in all cases had been performed more than 1 year before implant surgery.

The selected group of patients was treated by a team consisting of 2 oral and maxillofacial surgeons, 4 prosthodontists, and 1 dental hygienist. A total of 89 Brånemark implants (all of the standard 3.75-mm width, except for 1 of 4-mm diameter) were placed and allowed a healing period according to the manufacturer's protocol (Table 1). Five implants were removed prior to delivery of the prostheses, because of lack of osseointegration, 2 of which were replaced by new implants. Only 1 of these additional implants was utilized; the other was retained as a "sleeping" unit. In all, 85 implants were used as abutments, 54 of which were placed in the premolar and molar regions. Eighty-six teeth were prepared and used as natural abutments. Of these, 46 were vital, and 40 had received endodontic treatment. Foundations were placed in the latter, prior to the final impression.

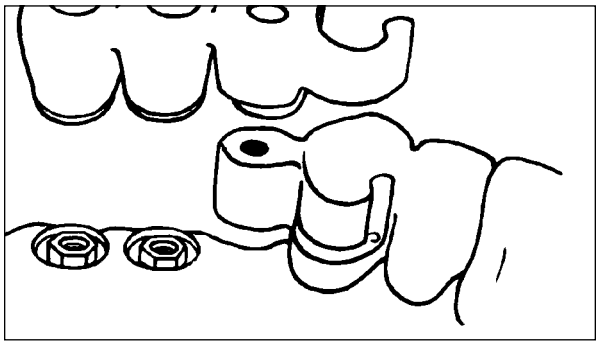

**Fig 1** The FPD connection, where a second prosthodontic segment is fastened with screws to both the implants and a first segment is cemented to natural teeth, with additional anchorage afforded by a rigid clasp arm. Modified versions of the illustrated principle had to be used where implants and teeth held neighboring positions.

Each of the 30 patients received 1 fixed prosthesis constructed as rigid, mutually screw-retained sections cast in noble alloy. Sixteen of these prostheses were fabricated with porcelain facings and 14 with composite polymer facings. With regard to size or extension, the FPDs varied from 3 to 13 units, with a mean of 8.6 units. The number of pontics did not exceed 2 adjacent, and was restricted to only 1 if cantilevered. According to the Applegate-Kennedy classification, 10 of the restorations were registered as Class I, 12 as Class II, and 4 each belonged to Classes III and IV. Individual hygiene instructions were given to each patient after the prosthesis delivery.

Information concerning the distribution of supporting units and types of prostheses (ceramic or composite facings) related to patient age and gender, as well as jaw location, is provided in Table 1. Approximately 66% of the FPDs were placed in patients between 50 and 70 years of age. Twenty-three of the prostheses were placed in maxillae and 7 in mandibles.

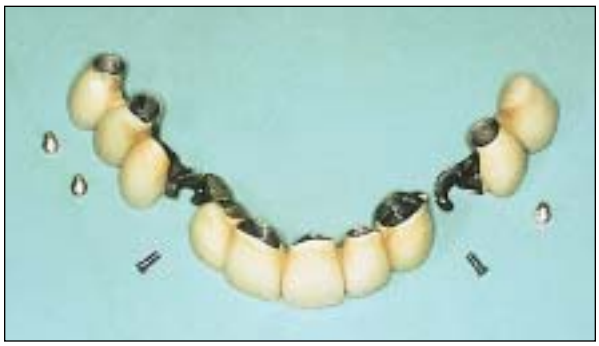

**Fig 2a** The partitioned FPD in a case where the first segment was to be cemented to 4 maxillary anterior teeth. The second segment in 2 lateral parts is shown together with fixation screws (ordinary gold screws for the implant abutments and small Swiss screws of precious metal for the connection).

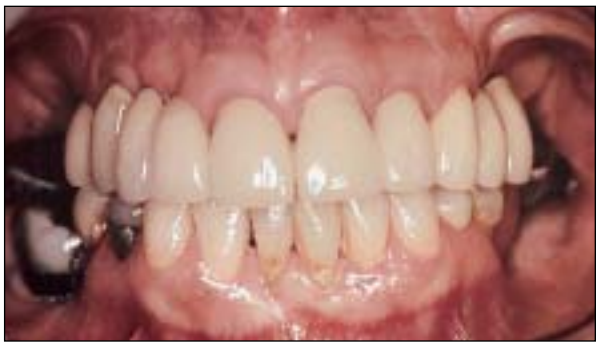

**Fig 2b** Intraoral photograph of the restorations at the 3-year follow-up examination.

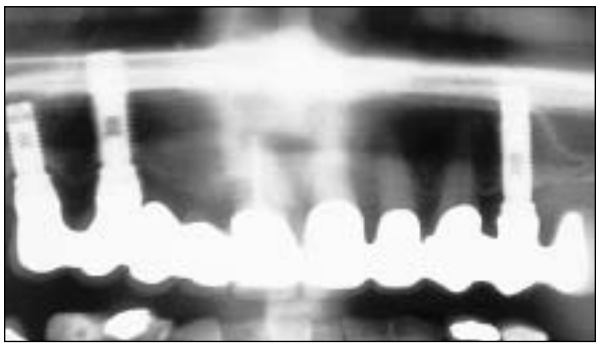

**Fig 2c** Maxillary segment of the orthopantomogram at the 3-year follow-up.

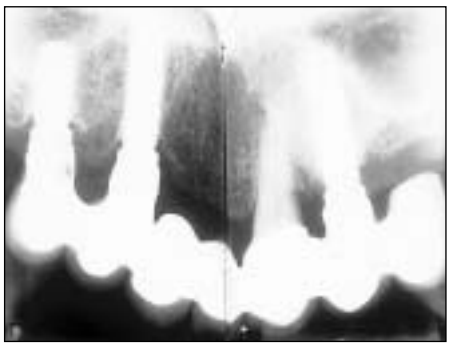

**Fig 2d** Intraoral radiographs of the implant locations at the 3-year follow-up.

In principle, the prostheses were fabricated in a first segment to be cemented to 1 or more natural teeth. To this was adapted a second segment (sometimes split into 2 parts), retained by conventional screw fixation to the supporting implants and with a clasp and screw fixation to the first segment. This design is represented pictorially in Fig 1. Thus, although the second segment was removable—and in some cases made as 2 sections, 1 on either end of the cemented stage—the finished and fully assembled restoration was acting as a rigid FPD. A clinical example is shown in Figs 2a to 2d.

The protocol included a baseline examination upon prosthesis delivery, followed by examinations after 1, 2, and 3 years. The clinical parameters to be checked at the 1- to 3-year follow-up were mobility of the implants and prostheses, bone levels adjacent to the implants, plaque accumulation, bleeding on probing, and pocket depths around the supporting abutments. Intraoral periapical radiographs and orthopantomograms were obtained after prosthodontic delivery and at the 1- and 3-year examinations. One patient, an 81-year-old man, died prior to the 2-year follow-up. Thus, only 29 patients could be followed throughout the investigation period.

## RESULTS

All 29 patients had stable fixed prostheses in place after 3 years. As stated above, 5 implants were removed during the preparatory stages (3 during the surgical stages and 2 during the prosthodontic preparation). Of the 85 implants used as abutments for the prostheses, 1 became loose and was removed prior to the 2-year follow-up. Another implant, having lost most of its bony attachment, was removed at the 3-year follow-up. The total of 7 implant losses in this study was plotted against implant length and jaw location (Table 2). Six implants were lost in the maxilla and 1 in the mandible. Five of the losses involved shorter implants: 3 were 7 mm long and 2 were 10 mm long. The losses were also matched with bone quality and gender (Table 3). Referring to the classification of Lekholm and Zarb,[12] 5 of the lost implants had been placed in category 3 bone

**Table 2 Implant Loss Related to Length and Jaw**

| Implant length | Maxilla | | Mandible | | Total | |
|---|---|---|---|---|---|---|
| | Placed | Lost | Placed | Lost | Placed | Lost |
| 7 mm | 5 | 3 | 1 | 0 | 6 | 3 |
| 10 mm | 16 | 2 | 5 | 0 | 21 | 2 |
| 13 mm | 30* | 0 | 5 | 1 | 35 | 1 |
| 15 mm | 15 | 1 | 10 | 0 | 25 | 1 |
| 18 mm | 1 | 0 | 1 | 0 | 2 | 0 |
| Total | 67 | 6 | 22 | 1 | 89 | 7 |

*One implant with diameter of 4 mm; all others were 3.75 mm in diameter.

**Table 3 Implant Loss Related to Bone Quality and Gender**

| Bone quality | Gender | Maxilla | | Mandible | | Total | |
|---|---|---|---|---|---|---|---|
| | | Placed | Lost | Placed | Lost | Placed | Lost |
| 1 | F | 0 | 0 | 0 | 0 | 0 | 0 |
| | M | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | F | 5 | 1 | 4 | 0 | 9 | 1 |
| | M | 0 | 0 | 8 | 0 | 8 | 0 |
| 3 | F | 40 | 4 | 6 | 0 | 46 | 4 |
| | M | 20 | 1 | 4 | 1 | 24 | 2 |
| 4 | F | 2 | 0 | 0 | 0 | 2 | 0 |
| | M | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | F | 47 | 5 | 10 | 0 | 57 | 5 |
| | M | 20 | 1 | 12 | 1 | 32 | 2 |
| | M and F | 67 | 6 | 22 | 1 | 89 | 7 |

(including the single mandibular loss), and 1 in category 2. As to gender, 5 implant losses occurred in women and 2 in men.

All complications encountered related to biologic as well as technical factors are listed in Table 4. One endodontically treated tooth was extracted after 3 years because of root fracture. The remainder were various intermediary tissue reactions, fractures of occlusal material/facings, and loosened composite screw hole plugs. All minor problems were properly treated.

## Life Tables

Separate life table analyses for implants in the maxilla and mandible gave cumulative survival rates after 3 years of 91.0% and 95.5%, respectively (Table 5).

## Plaque Formation

The incidence of plaque around the implants and teeth involved was recorded at the 1- and 3-year follow-up visits, revealing only minor changes (Table 6). Large deposits were not noted, and the majority of the registrations were of the "no plaque" type (67% at both registrations for the implants, and increasing from 64% to 77% for the supporting teeth). The figures for a film of plaque was 33% on the implants and 34% on the teeth at 1 year, changing to 32 and 22% at 3 years, respectively.

## Gingival Status

The provoked bleeding on probing test showed no bleeding around 66% of the implants and 68% of the teeth at the 1-year appointment, whereas the corresponding figures at 3 years were 59% and 60% (Table 7). Observed bleeding on probing, on the other hand, changed from 34% around implants and 32% around teeth to 41% and 40%, respectively. Spontaneous bleeding was never observed.

## Pocket Depth

Measurements of pocket depths showed pockets < 4 mm found at 69% of the implants and 78% of the supporting teeth at the 1-year appointment, changing to 60% and 81% after 3 years (Table 8). Pocket depths ≥ 4 mm were found at 31% of the implants

**Table 4 Complications Encountered**

| | No. of complications |
|---|---|
| Implant failure | 7 |
| Paresthesia | 2 |
| Edema | 3 |
| Hematoma | 3 |
| Exposure of healing cap | 4 |
| Fracture of occlusal porcelain | 5 |
| Other complications | 14 |

Specifications of "other complications": oroantral communication, 1; membrane covered implant, 1; inflammation at implant-abutment junction, 2; root fracture + extraction of supporting tooth, 1; pocket depth > 5 mm on supporting tooth, 2; fistula related to supporting tooth, 1; fracture of facing, 3; replacement of composite "plug," 3. Some patients experienced more than one complication.

**Table 5 Life-Tables Revealing Cumulative Survival Rates (CSR) of Maxillary and Mandibular Implants**

| Time period | Implants | Failed | Withdrawn | CSR (%) |
|---|---|---|---|---|
| Maxilla | | | | |
| Placement–loading | 67 | 4 | 0 | 94.0 |
| Loading–1 year | 63 | 0 | 0 | 94.0 |
| 1–2 years | 63 | 1 | 0 | 92.5 |
| 2–3 years | 62 | 1 | 0 | 91.0 |
| Mandible | | | | |
| Placement–loading | 22 | 1 | 0 | 95.5 |
| Loading–1 year | 21 | 0 | 0 | 95.5 |
| 1–2 years | 21 | 0 | 3 | 95.5 |
| 2–3 years | 18 | 0 | 0 | 95.5 |

**Table 6 Plaque Registrations at Supporting Implants and Teeth After 1 and 3 Years**

| | Implants (n = 302)* | | Teeth (n = 138)† | |
|---|---|---|---|---|
| | n | % | n | % |
| 1 year | | | | |
| No plaque | 203 | 67 | 89 | 64 |
| A film of plaque | 99 | 33 | 47 | 34 |
| Moderate accumulation | 0 | 0 | 2 | 1 |
| 3 years | | | | |
| No plaque | 201 | 67 | 106 | 77 |
| A film of plaque | 97 | 32 | 31 | 22 |
| Moderate accumulation | 4 | 1 | 1 | 1 |

Four approximal sites per unit.
*One implant became lost (4 sites) and 1 patient died (12 sites) before the 3-year follow-up. Sixteen sites are withdrawn at the 3 years, and the 1-year registrations of these sites are not included in the Table. Information of 18 sites at the 1- and 3-year follow-up is missing.
†One tooth was extracted (4 sites) and 1 patient died (8 sites) before the 3-year follow-up. Twelve sites are thus withdrawn at the 3 years, and 1-year registrations of these are not included in the Table. Information of 10 sites at the 1-year and 3-year follow-up is missing.

**Table 7 Mucosal/Gingival Bleeding of Supporting Implants and Teeth After 1 and 3 Years**

| | Implants (n = 145)* | | Teeth (n = 63)† | |
|---|---|---|---|---|
| | n | % | n | % |
| 1 year | | | | |
| No bleeding on probing | 96 | 66 | 43 | 68 |
| Bleeding on probing | 49 | 34 | 20 | 32 |
| Spontaneous bleeding | 0 | 0 | 0 | 0 |
| 3 years | | | | |
| No bleeding on probing | 86 | 59 | 38 | 60 |
| Bleeding on probing | 59 | 41 | 25 | 40 |
| Spontaneous bleeding | 0 | 0 | 0 | 0 |

Two approximal sites per unit.
*One implant became lost (2 sites) and 1 patient died (6 sites) before the 3-year follow-up. Eight sites are thus withdrawn at 3 years, and 1-year registrations of these are not included in the Table. Information of 15 sites at the 1- and 3-year follow-up is missing.
†One tooth was extracted (2 sites) and 1 patient died (4 sites) before the 3-year follow-up. Six sites are thus withdrawn at 3 years, and the 1-year registrations of these are not included in the Table. Information of 11 sites at the 1-year and 3-year follow-up is missing.

**Table 8 Pocket Depths of Supporting Implants and Teeth After 1 and 3 Years**

| | Implants (n = 152)* | | Teeth (n = 68)† | |
|---|---|---|---|---|
| | n | % | n | % |
| 1 year | | | | |
| < 4 mm | 105 | 69 | 53 | 78 |
| ≥ 4 mm | 47 | 31 | 15 | 22 |
| 3 years | | | | |
| < 4 mm | 91 | 60 | 55 | 81 |
| ≥ 4 mm | 61 | 40 | 13 | 19 |

Two approximal sites per position.
*One implant became lost (2 sites) and 1 patient died (6 sites) before the 3-year follow-up. Eight sites are thus withdrawn at 3 years, and 1-year registrations of these are not included in the Table. Information of 8 sites at the 1- and 3-year follow-up is missing.
†One tooth was extracted (2 sites) and 1 patient died (4 sites) before the 3-year follow-up. Six sites are thus withdrawn at 3 years, and 1-year registrations of these are not included in the Table. Information of 6 sites at the 1-year and 3-year follow-up is missing.

**Table 9 Marginal Bone Loss at Supporting Implants and Teeth Between Prosthesis Placement and the 3-year Follow-up**

| | Implants 0–3 y | | | Teeth 0–3 y | | |
|---|---|---|---|---|---|---|
| | n | Mean loss (mm) | SD (mm) | n | Mean loss (mm) | SD (mm) |
| Total | 59* | 0.8 | 1.1 | 17† | –0.1 | 0.8 |
| Maxilla | 52 | 0.8 | 1.1 | | | |
| Mandible | 7 | 0.8 | 0.9 | | | |
| Women | 43 | 0.9 | 1.2 | | | |
| Men | 16 | 0.6 | 0.6 | | | |

*Missing radiographs from 25 positions at the baseline, prosthesis placement, or the 3-year follow-up.
†Missing radiographs from 23 positions at the baseline, prosthesis placement, or the 3-year follow-up.

and 22% of teeth after 1 year. At the 3-year appointment, the corresponding figures were 40% and 19%.

### Marginal Bone Level Changes

The marginal bone level measurement upon prosthesis placement, as compared to the level registered after 3 years, reflected a mean bone reduction (± SD) at implant sites of 0.8 ± 1.1 mm (Table 9). This was the case for both jaws, whereas the overall mean for women (0.9 ± 1.2 mm) was slightly higher than for men (0.6 ± 0.6 mm). However, the bone level at supporting teeth revealed an apparent increase in the same time span, ie, mean –0.1 ± 0.8 mm.

To the above referred findings should be added the fact that the patients in general regarded the received treatment as a considerable asset on the personal level.

## DISCUSSION

The present study combined endosseous implants and natural teeth as abutments for fixed prostheses in a variety of clinical situations. The outcome was followed over 3 years. An exhaustive investigation of related biologic and mechanical aspects would require much larger groups of both FPD designs and supporting oral conditions. It was felt that the general biologic capacity for accepting such prostheses had been underestimated, and a practical, small-scale investigation was deemed possible. As for patient selection, it seemed that the accepted group corresponded reasonably well with dentate individuals of the same age (cohorts) and also in need of prosthodontic treatment.

Previous investigations of a similar treatment modality[5–7] dealt with only 1 implant and 1 natural tooth supporting a small FPD. The present study involved only 1 case of a similar design. In all, a variety of segmented FPDs were supported by equal numbers of implants and teeth in 23% of the cases, while implants outnumbered the teeth in 43% and the opposite was seen in 33%.

Of the 5 early implant losses, 4 had been placed in the maxilla and 1 in the mandible. The 2 losses after prosthesis placement (failures that might be associated with the prosthodontic treatment modality) were maxillary implants. In general, the reported loss of 7 implants and other complications related to the placement of implants was similar to those reported previously.[8,13–15] These involved early loss of implants, loss of mainly maxillary implants, loss of relatively short implants, and failures after placement in reduced jawbone quality dominated by spongeous structure (Tables 2 and 3). The difference between genders in implant losses (5 in women versus 2 in men) is to be expected, as there were twice as many female as male patients in the present study.

An endodontically treated maxillary canine in a 3-unit FPD was extracted because of root fracture (Table 4), and the retainer was converted into a pontic. This tooth had been anchored to 2 neighboring implants in premolar locations, and it was considered that the fracture was more related to previous treatment factors than to introduction of the mentioned FPD. The remainder of the complications encountered were associated with soft tissue and some minor prosthodontic repair needs. All problems were transient in nature and were resolved without difficulty.

Life tables for the maxillary and mandibular implants in this study revealed a cumulative survival rate of 91.0% in the maxilla, whereas in the mandible, with 3 implants excluded after a patient's death, the corresponding rate was 95.5% (Table 5). These figures can be said to match well with those of similar studies.

Changes in soft tissue health and bone levels observed through the 3 years were quite modest. With the inherent diversity of clinical variables in this treatment project, further statistical testing in this respect was considered inappropriate.

The distribution of mainly plaque-free surfaces or small amounts of plaque was essentially the same throughout the investigation for the implants, whereas a slight improvement was seen on the tooth surfaces. Mucosal/gingival bleeding testing revealed that although no bleeding was the predominant finding, a slight tendency toward increased bleeding could be discerned at both implant and tooth sites. Pocket depth around implants has been discussed, and was included in this investigation as it was believed to be related to bony fixation. The results parallelled the provoked bleeding test findings in that a tendency toward increased pocket depth was observed around supporting implants.

Bone level measurements after prosthesis delivery (to the 3-year examination) exhibited a similar tendency. A mean reduction of 0.8 ± 1.1 mm was observed at the implant sites, whereas an apparent increase in bone height was found around the supporting teeth (–0.1 ± 0.8 mm).

Based on the present study, it is not possible to elucidate clearly the reasons for these small changes. These can hardly be ascribed to the combination of implants and teeth as support for FPDs. A better monitoring of the oral hygiene routines might otherwise have influenced findings of this kind. Therefore, the data confirmed the consistent mucosal/gingival health in this patient group.

With regard to the outcome of this 3-year study, the overall findings and the patient satisfaction in general indicate that such a treatment modality may form an important adjunct to available prosthodontic options. Although the specific attachment system between components of the prosthesis has been shown to function well, a simpler prosthodontic restoration should be considered in future projects. In general, clinical evaluation of design will be needed to establish better criteria for when and how natural teeth and implants may be combined as support for FPDs. A long-term study of the related anchorage, in situations more or less parallelling the cases in the present study, should be regarded as an interesting field for future investigations.

## ACKNOWLEDGMENTS

The contributions to this clinical study from oral and maxillofacial surgeon Trond I. Berge; prosthodontists Einar Berg, Anne-Marie Halmöy, and Edgar Sörheim; dental hygienist Eli-Karin Sövdsnes; consulting engineer Gerd Johannessen; and the dental laboratory Dentalstöp Tannteknisk Laboratorium AS; are deeply appreciated.

## REFERENCES

1. Cohen SR, Orenstein JH. The use of attachments in combination implant and natural-tooth fixed partial dentures: A technical report. Int J Oral Maxillofac Implants 1994;9:230–234.
2. Rangert B, Gunne J, Sullivan DY. Mechanical aspects of a Brånemark implant connected to a natural tooth: An in vitro study. Int J Oral Maxillofac Implants 1991;6:177–186.
3. Rangert B, Gunne J, Glantz PO, Svensson A. Vertical load distribution on a three-unit prosthesis supported by a natural tooth and a single Brånemark implant. An in vivo study. Clin Oral Implants Res 1995;6:40–46.
4. Lundgren D, Laurell L. Biomechanical aspects of fixed bridgework supported by natural teeth and endosseous implants. Periodontol 2000 1994;4:23–40.
5. Åstrand P, Borg K, Gunne J, Olsson M. Combination of natural teeth and osseointegrated implants as prosthesis abutments: A 2-year longitudinal study. Int J Oral Maxillofac Implants 1991;6:305–312.
6. Olsson M, Gunne J, Åstrand P, Borg K. Bridges supported by free-standing implants versus bridges supported by tooth and implant. A five-year prospective study. Clin Oral Implants Res 1995;6:114–121.
7. Gunne J, Åstrand P, Lindh T, Borg K, Olsson M. Tooth-implant and implant supported fixed partial dentures: A 10-year report. Int J Prosthodont 1999;12:216–221.
8. Cavicchia F, Bravi F. Free-standing versus tooth-connected implant-supported fixed partial restorations: A comparative retrospective clinical study of the prosthetic results. Int J Oral Maxillofac Implants 1994;9:711–718.
9. Gross M, Laufer BZ. Splinting osseointegrated implants and natural teeth in rehabilitation of partially edentulous patients. Part I: Laboratory and clinical studies. J Oral Rehabil 1997;24:863–870.
10. Laufer BZ, Gross M. Splinting osseointegrated implants and natural teeth in rehabilitation of partially edentulous patients. Part II: Principles and applications. J Oral Rehabil 1998;25:69–80.
11. Hosny M, Duyck J, van Steenberghe D, Naert I. Within-subject comparison between connected and nonconnected tooth-to-implant fixed partial prostheses: Up to 14-year follow-up study. Int J Prosthodont 2000;13:340–346.
12. Lekholm U, Zarb GA. Patient selection and preparation. In: Brånemark P-I, Zarb GA, Albrektsson T (eds). Tissue-Integrated Prostheses. Chicago: Quintessence, 1985:199–209.
13. Jemt T. Failures and complications in 391 consecutively inserted fixed prostheses supported by Brånemark implants in edentulous jaws: A study of treatment from the time of prosthesis placement to the first annual checkup. Int J Oral Maxillofac Implants 1991;6:270–276.
14. Jemt T. Failures and complications in 127 consecutively placed fixed partial prostheses supported by Brånemark implants: From prosthetic treatment to first annual checkup. Int J Oral Maxillofac Implants 1992;7:40–44.
15. Hemmings KW, Schmitt A, Zarb GA. Complications and maintenance requirements for fixed prostheses and overdentures in the edentulous mandible: A 5-year report. Int J Oral Maxillofac Implants 1994;9:191–196.