Five-mm-Diameter Implants without a Smooth Surface Collar: Report on 98 Consecutive Placements

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In recent years, indications for endosseous dental implants have been extended to include partially edentulous jaws with areas of limited bone density and bone volume. Wide-diameter implants are particularly well suited for these situations. The purpose of this paper was to report on 98 consecutively placed 5-mm-diameter implants without smooth surface collars. Eight implants failed—6 at second-stage surgery, and 2 after 1 year of loading (91.8% survival rate). Sixty percent of the remaining implants had no thread above the bone level after 1 year of loading. The authors discuss the possible causes for failure and suggest guidelines to avoid failure.
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Key words: bone loss, dental implant, wide diameter

Endosseous dental implants initially showed very high survival rates in completely edentulous patients.[1] Subsequently, the indications for implants were extended to include partially edentulous jaws with areas of limited bone density and/or bone volume. In addition, to facilitate the replacement of a failing standard implant and to improve the success rate in compromised situations, wide-diameter implants were introduced. The 5-mm-diameter implant without a smooth surface collar (Brånemark System, Nobel Biocare AB, Göteborg, Sweden) has threads machined to the level of the hexagonal head. These threads are also deeper than those found on a standard implant (0.4 mm instead of 0.3 mm) (Fig 1). These features allow an implant 5 mm wide and 6 mm long to maintain the same area of bone contact as a 3.75 × 10 mm implant. The absence of a smooth collar at the level of the hexagonal head eliminates the need to countersink the implant site and enables visual control of the depth of the implant (Fig 2).

Although Langer et al[2] have advocated the use of these implants in posterior areas, very little new information has been published since then.[3] Therefore, the purpose of this paper is to report on 98 consecutively placed 5-mm-diameter implants without a smooth surface collar.

Materials and Methods

Between October 1992 and November 1995, ninety-eight 5-mm-diameter implants without a smooth surface collar were consecutively placed in 74 patients (30 males and 44 females) (Table 1). The average age of these patients was 54 years. Thirty-three implants were placed in the maxilla and 65 in the mandible. The implant length ranged from 6 to 12 mm (Table 2). Bone quality and bone quantity were evaluated using computed tomographic scanning. Five-mm-diameter implants were placed in clinical situations with reduced bone height (less than 8 mm) and/or reduced bone density (Type 3 or 4). They were also used to replace single posterior teeth (in 14 patients) or implants that did not integrate (in 9 patients).

Implants were placed following the protocol suggested by Nobel Biocare. A 3-mm twist drill was first used, followed by a 4.3-mm pilot drill, fol-

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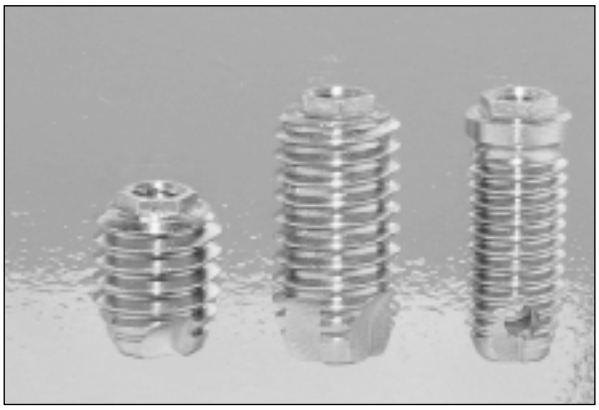


Fig 1 *(Left, center)* Two 5-mm-diameter implants without a smooth surface collar (Brånemark System) next to *(right)* a standard implant (Brånemark System). A 6-mm-long × 5-mm-diameter implant develops the same bone surface contact as a 10-mm-long standard-diameter implant.

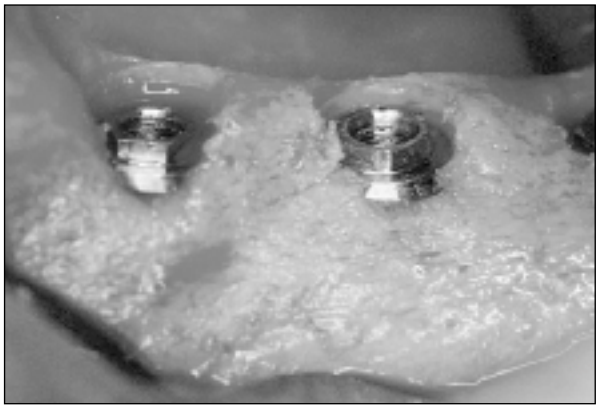


Fig 2 *(Left)* A standard implant and *(right)* a 5-mm-diameter implant at stage 1 surgery. Note that the first thread of the 5-mm-diameter implant is at the bone crest. This implant is designed to increase the amount of anchorage.

Table 1 Implant Placement Information

Date	No. of implants placed	No. of implants that failed
10-92 to 04-93	9	1
05-93 to 07-93	5	–
09-93 to 11-93	12	2
12-93 to 02-94	6	–
04-94 to 06-94	10	1
07-94 to 10-94	12	1
11-94 to 01-95	15	2
02-95 to 04-95	12	–
05-95 to 07-95	11	1
09-95 to 11-95	6	–
Total no. placed	98	8

lowed by a 4.3-mm twist drill. When the bone was dense, a 3.7-mm twist drill was used prior to the pilot drill. Although dense bone was tapped, it was possible to self-tap implants when lesser density was encountered. They were buried up to the mount-implant junction. A hexagonal cover screw was placed on all implants.

There was no modification of the second-stage surgical procedure, compared to that used with 3.75-mm-diameter implants. Prosthetically, since there was no marginal flange, the abutments used for the standard implant (Standard, EsthetiCone, CeraOne; Nobel Biocare AB) were also used for this wide implant.

Implants were examined radiographically after 1 year of loading using periapical radiographs mounted on a standard angulator. The platform of the implant was used as a reference. Bone loss was evaluated by counting the number of threads above the bone level and multiplying by 0.8 mm (thread pitch). Mesial and distal measurements were recorded and averaged.

Results

Ninety-eight wide-diameter implants were placed between October 1992 and November 1995, and 8 implants (three 6-mm implants, two 8-mm implants, and three 10-mm implants) were removed. Therefore, the overall survival rate was 91.8%. Of these 8 implants, 6 were found not to be integrated at the time of uncovering (93.8% survival rate at this stage; Table 3); 3 implants had been placed in unfavorable preoperative conditions in patients 2, 4, and 7; and 3 implants were lost after replacement of nonintegrated standard-size implants in patients 1 (who lost 2 implants at the same time) and 6. The remaining 2 implants, in patients 3 and 5, failed after 1 year of loading. Both of them were replacing previous standard implants that became mobile after loading (Table 4).

Bone loss was first measured at the time of second-stage surgery. Eighty-five of the 92 osseointegrated implants had no threads exposed (86.7%). Of the remaining 7 implants, 5 had 2 threads exposed and 2 had 3 threads exposed. Five of these implants were in the region of the mandibular molars, 1 was in the region of a maxillary molar, and 1 was in the region of a mandibular second premolar (Table 5).

Bone loss was then assessed radiographically after 1 year of loading on 80 implants (10 implants were not analyzed because of patients failing to attend their appointment). Forty-eight (60%) of the

Table 2 Position and Length of Implants

	Length (mm)				
Position	6	8	10	12	Total placed
Maxilla					
Right second molar	1	–	–	1	2
Right first molar	2	2	–	–	4
Right second premolar	3	–	–	–	3
Right first premolar	–	–	–	–	0
Right canine	1	–	–	1	2
Left second molar	1	2	2	–	5
Left first molar	–	3	6	1	10
Left second premolar	2	2	–	1	5
Left first premolar	–	–	–	–	0
Left canine	1	1	–	–	2
Subtotal	11	10	8	4	33
Mandible					
Right second molar	7	3	3	1	14
Right first molar	7	4	2	1	14
Right second premolar	–	3	2	1	6
Right first premolar	–	–	1	–	1
Right canine	–	–	–	–	0
Left second molar	4	2	2	1	9
Left first molar	6	3	3	2	14
Left second premolar	3	1	–	1	5
Left first premolar	1	–	–	–	1
Left canine	–	–	1	–	1
Subtotal	28	16	14	7	65
Total	39	26	22	11	98

Table 3 Life Table Analysis of 5-mm-diameter Brånemark Implants Without a Smooth Surface Collar (n = 98)

	Failed	Surviving	No threads exposed
Second-stage surgery	6	92 (93.8%)	85 (86.7%)
1 year loading	2	90 (91.8%)	48 (60%; 10 implants were not checked)

Table 4 Location and Possible Explanation of Failed Implants

Implant position	Implant length (mm)	Possible explanation	Patient
Mandibular right first molar	10	Immediate replacement of a nonintegrated 3.75-mm implant	Patient 1
Mandibular right first molar	8	Immediate replacement of a nonintegrated 5-mm implant	Patient 1
Maxillary right canine	8	Implant in the maxillary median suture	Patient 2
Mandibular right second molar	6	Lost 1 year after loading (mechanical overload)	Patient 3
Maxillary right second premolar	6	Type 4 bone	Patient 4
Mandibular left second premolar	6	Lost 1 year after loading (peri-implantitis)	Patient 5
Mandibular left first molar	10	Immediate replacement of a nonintegrated 3.75-mm implant	Patient 6
Maxillary left second molar	6	Type 4 bone	Patient 7

Table 5 Loss of Bone at Second-stage Implant Surgery

Implant position	Implant length (mm)	No. of threads exposed	Patient
Mandibular left second molar	6	2	Patient 1
Mandibular right second premolar	10	3	Patient 2
Mandibular left first molar	12	3	Patient 3
Maxillary left first molar	10	2	Patient 4
Mandibular right second molar	6	2	Patient 5
Mandibular right first molar	8	2	Patient 6
Mandibular left second molar	8	2	Patient 7

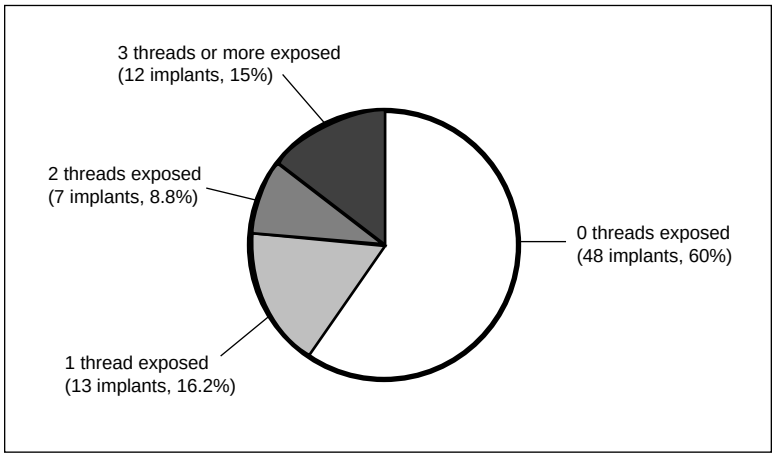


Fig 3 Number of threads exposed 1 year after loading in 80 osseointegrated and controlled implants.

remaining implants had no thread above the alveolar crest, 13 implants (16.2%) had 1 thread not in contact with bone, 7 implants (8.8%) had 2 threads exposed, and 12 implants (15%) had 3 or more threads exposed. The cumulative number of implants presenting 1 or more threads above the marginal bone level after 1 year was 32 (40%) (Fig 3). Within the limitations of the measurement technique, the mean bone loss around these implants after 1 year was 0.63 ± 0.3 mm (SD).

Discussion

The wide-diameter implant was first introduced to fulfill 2 indications: poor bone quality and/or quantity, and replacement of a failing standard implant.[2] To evaluate the clinical usage of the 5-mm-wide implant, survival and success rates have been examined.

To evaluate implant survival, presence or absence of the implant is the determining criterion. The implant survival rate had previously been closely related to 2 parameters; bone density[4–6] and bone quantity.[7–9] Despite the relative lack of publications addressing this issue, large-diameter implants seem to have a high survival rate. Davarpanah et al[10] reported 96% survival, after 2 years, of fifty-five 5-mm-diameter implants (Nobel Biocare). Graves et al[11] placed 266 large-diameter 3i implants in 196 patients in Type 3 or 4 bone with a 2-year follow-up and reported only 11 osseointegration failures. The survival rate was found to be 94% in the mandible and 98% in the maxilla. But Minsk et al,[12] in a retrospective study of 1,263 implants, reported a higher failure rate for large-diameter implants (15% to 16%) than for standard or narrower-diameter implants (1% to 9%). Overall, these results are encouraging, since the wide-diameter implants are generally selected for unfavorable situations (poor bone density, poor bone volume, or single molar replacement; Fig 4).

In the present study, an overall survival rate of 91.8% is reported. Among the 8 failed implants, 6 were lost at second-stage surgery, which was performed between 5 and 6 months after implant placement. Three of the affected patients were examined clinically and radiographically 3 months after implant placement, but no signs of pathology were detected. It was hypothesized that bone loss occurred around the fourth month after implant

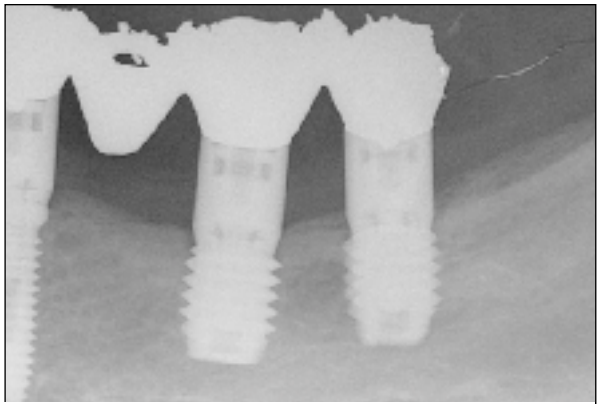
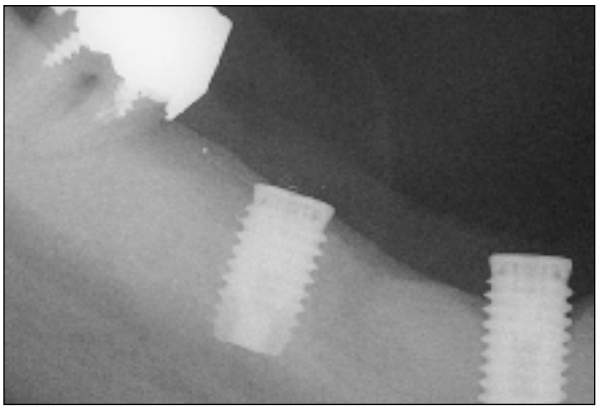
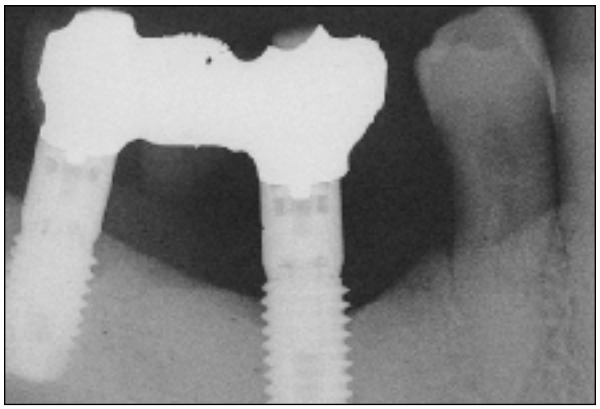


Fig 4 Two 5-mm-diameter implants in the area of the first and second mandibular molars were selected because of the proximity to the mandibular alveolar nerve. One year after loading, the original bone level was maintained.





Figs 5a and 5b Two 5-mm-diameter implants, in the area of second premolar and second molar, were positioned in Type 1 bone. *(Left)* Radiographic view, before stage 2 surgery, shows bone loss to the third thread on the mesial implant, which occurred between the fourth and the sixth month after placement. *(Right)* After 2 years, the radiograph shows a stable bone loss on the mesial implant, while the distal implant presents proximal radiolucencies.

placement. This phenomenon can be compared with the elimination of a sequestrum after osteitis. Patient 1 first lost a 3.75-mm-diameter implant and then two 5-mm-diameter implants, all in the same area (mandibular right first molar) before loading. This patient did not present any contributory medical history. The microbiologic tests did not reveal the presence of any particular periodontal pathogen. Thus, these 2 failures could not be explained.

Patient 3 received three 5 × 6 mm implants to replace the mandibular right molars and lost one implant. This failure was associated with heavy bruxism and poor occlusal landmark relationships. Finally, 1 implant in patient 4 was lost because of an infection. As a result of the failures, the following protocol has now been adopted. Surgery is delayed 6 to 8 weeks after removal of a loaded implant. This allows for complete disinfection of the site and soft tissue closure. By contrast, an implant removed at the time of uncovering would be replaced immediately.

Although the survival rate is high for 5-mm-wide implants without a smooth surface collar, it is of interest to examine their level of success, using the criteria defined by Albrektsson et al[13] and recommended by the American Academy of Periodontology.[14] Among them, the requirement for a long-term observation period could not be met. Nevertheless, no persistent pain, infection, or paresthesia was encountered in any of these patients. The remaining criterion of interest is the amount of bone loss around the implants. Interestingly, cases

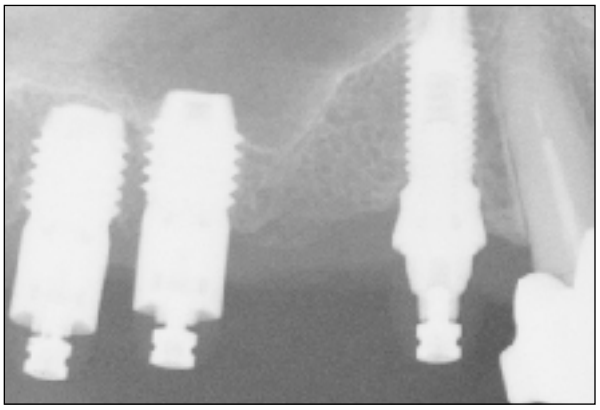


Fig 6a Radiograph showing clinical situation of 2 implants 5 mm wide and 6 mm long. Shortly after stage 2 surgery, the bone level remained at the collar.

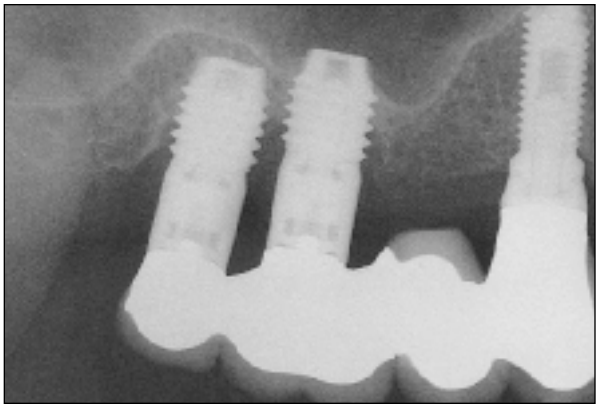


Fig 6b One year after loading, bone loss has occurred, mostly around the distal implant.

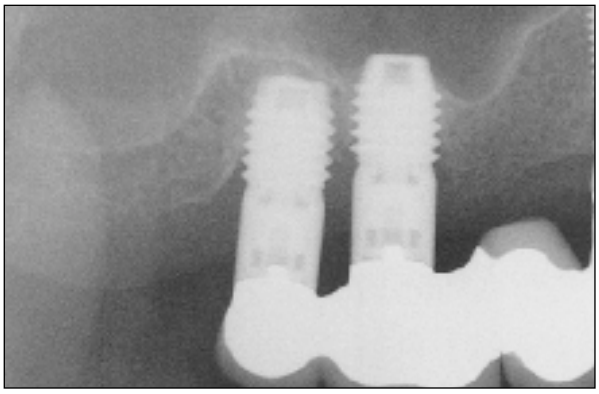


Fig 6c Three years after loading, the bone level is stabilized and seems to have improved, particularly between the 2 implants, although no specific treatment was attempted.

of bone loss that occurred before second-stage surgery were observed primarily for long implants (more than 8 mm; 4 patients out of 4) or for implants placed into very dense bone (4 patients out of 7; Figs 4 and 5). Overheating or trauma to the cortical portion of the bone is a possible explanation. In the original surgical protocol for placement of wide implants, the use of wide-diameter drills may have contributed to this necrosis. Another possible explanation is excessive compression of the bone when a progressive drilling sequence is not used. This theory would explain the delayed bone loss and lack of clinical signs. Similar bone loss was observed by Renouard et al[15] with wide-diameter implants that featured a smooth collar (Brånemark System, Nobel Biocare AB).

The authors suggest not using the usual drill sequence. After the 3-mm twist drill, they advocate the use of a standard conical bur at high speed and then a 3.85-mm drill before implant placement. With dense bone, a tap can be used, but not to the full length. Only the most coronal aspect can be tapped to facilitate implant placement. Then, the final turns are usually executed by hand, using the cylinder wrench. This sequence allows for more control of site preparation, and may prevent the marginal bone loss sometimes encountered with large-diameter implants.

After 1 year of loading of standard-size implants, Adell et al[1] reported a mean bone loss of 1.5 mm and Cox and Zarb[16] reported a mean bone loss of 1.6 mm. Our results showed a mean bone loss of 0.63 mm within the same period of time. A classical explanation for this loss during the first year of loading is the establishment of a biologic width.[17] It could also be related to excess mechanical stress or microleakage at the implant-abutment interface.[18] Nevertheless, no bone loss was detected in as many as 60% of these implants (Fig 6).

These results suggest that bone loss around wide-diameter implants without a smooth surface collar is comparable to that reported around standard-diameter implants. Yet what is considered an acceptable degree of bone loss around standard implants may lead to clinical difficulties with this system. Since there is no smooth surface collar, any recession will result in exposed threads. The threads, which are deeper than those used on standard implants (0.4 mm instead of 0.3 mm), may become bacterial traps that may be particularly difficult to debride. Furthermore, the 5-mm-diameter implant is often elected in situations where bone height is low, so that short implants are chosen. Bone loss is therefore proportionally more important with these implants than with those of standard length.

Conclusion

Wide-diameter implants have been developed for compromised clinical situations, as well as to replace failing standard diameter implants. An increasing number of wide-diameter implants are being suggested for use in the posterior part of the jaws as well as for the replacement of single molars and premolars. Although these implants offer a predictable therapeutic solution, their long-term behavior is still uncertain, especially for implants with exposed threads. Nevertheless, survival and success rates presented in this report are similar to the ones reported for standard-size implants. Possible modifications of the surgical step are suggested, but more studies are necessary to determine the ideal protocol for the successful placement of wide-diameter implants.

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