Clinical Analysis of Wide-Diameter Frialit-2 Implants

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Purpose: *To evaluate wide-diameter (ie, 5.5-mm-wide) Frialit-2 implants used for several forms of prosthetic rehabilitation.* ***Materials and Methods:*** *In this retrospective study, 121 wide implants (74 maxillary, 47 mandibular) were placed in 114 patients (61 female, 53 male, mean age 37.2 ± 14.9 years). Thirty-six single-tooth restorations, 63 fixed partial dentures (68 implants), 6 removable overdentures (7 implants), and 3 fixed complete dentures (8 implants) were placed. Eighty-seven were placed in the molar regions. The follow-up period for the implants was 12 to 114 months (mean 41.8 ± 18.5 months). Peri-implant bone loss, pocket depth, Plaque Index values, Bleeding Index values, and Periotest values were evaluated.* ***Results:*** *Overall, 2 maxillary implants were lost, for a cumulative survival rate of 98.3% (97.3% in the maxilla; 100% in the mandible). Mean peri-implant pocket depth (3.4 ± 1.1 mm), bone resorption (1.4 ± 1.2 mm), Periotest values (−4.3 ± 3.1) as well as the Plaque Index and Bleeding Index (grades of 0 in 80% of cases) indicated acceptable results.* ***Discussion:*** *The high survival rate may be attributed to avoidance of the use of short wide-diameter implants, and the primary intention to place wide-diameter implants. Preference of the molar region was a consequence of the peri-implant bone situation in the premolar region, which was frequently inadequate for a 5.5-mm implant.* ***Conclusions:*** *The use of wide-diameter implants can be a viable treatment option and may provide benefits in posterior regions for long-term maintenance of various implant-supported prosthetic rehabilitations. Some anatomic and prosthodontic limitations for the use of wide implants were identified.* INT J ORAL MAXILLOFAC IMPLANTS 2004;19:710–715

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In recent years, the use of dental implants with a wider diameter than that of standard implants has been increasingly common in clinical practice.[1,2] Wide-diameter implants were initially introduced as rescue implants and were predominantly used in the posterior region upon failure of standard-width implants to allow adequate anchorage of endosseous implants in cases of reduced bone quantity and/or quality.[2–4] However, wide-diameter implants are increasingly being used for implantation in fresh extraction sites and in patients with poor bone quality, reduced bone height, and/or a habit of bruxism.[5–7]

Because of their larger surface area, wide-diameter implants (more than 3.75 mm wide) enhance connectivity with the surrounding bone and show an anchorage strength 3- to 6-fold of that of standard-diameter implants.[8,9] Experimental studies have shown that wide-diameter implants are associated with increased removal torque values and that the load on cortical bone decreases with increasing implant diameter.[8,9] Wide-diameter implants also can provide for improved esthetic results because they encourage an optimized soft tissue profile and facilitate oral hygiene for the patient.[3,6,10]

The wide-diameter implant on which the most studies have been done is the Brånemark System implant (Nobel Biocare, Göteborg, Sweden).[2–7,11–13] Several studies of the Brånemark implant describe contradictory results.[11–13] Recent results of Friberg and associates[12] indicated a loss rate of 4.5% for wide-diameter implants (5.0 mm) and showed no differences in survival rates between 5.0-mm, 4.0-mm, and 3.75-mm implants. However, unfavorable results for wide-diameter implants have also been reported.[11] Langer and colleagues[4] described a survival rate of 75% to 87% in a 3-year study. Extremely high loss rates (18%) of wide-diameter implants have also been described by Ivanoff and coworkers,[13] who reported a significantly higher failure rate for wide-diameter implants than for

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implants of standard diameter. Interestingly, only 10% of the wide-diameter implants used by Ivanoff and coworkers had a length of more than 10 mm; the implants studied were predominantly short wide-diameter implants (6 to 8 mm long).

Apart from the satisfactory results described for wide-diameter Brånemark System implants, consistently good and encouraging outcomes have also been reported for other implant systems, with survival rates of 94% to 98%.[2,14,15] Khayat and associates[14] observed a survival rate of 95% for wide-diameter Screw-Vent implants (Paragon, Encino, CA). A survival rate of 100% throughout the follow-up period was found for 43 wide-diameter implants that were 13 mm long or longer.

Although a variety of procedural details on how and when to use wide-diameter implants have been published, there is an obvious lack of published data from clinical studies.[4,6] Thus, the present investigation was intended to report results and experience with wide-diameter Frialit-2 implants (Friatec, Mannheim, Germany). Evaluation of the 5.5-mm-wide implants specifically included assessment of implant length, implant location, and prosthetic use.

MATERIALS AND METHODS

Patient and Implant Selection

The study included 114 patients (61 female, mean age 36.5 ± 14.7 years; 53 male, mean age 41.2 ± 16.3 years), consecutively receiving at least 1 Frialit-2 5.5-mm-wide implant between January 1994 and July 2001. The primary indication for the placement of 5.5-mm implants was to obtain an optimal soft tissue profile and to achieve adequate stability in patients with reduced bone quality or quantity. All wide Frialit-2 implants were placed by primary intention; none were used as rescue implants. For the support of fixed or removable partial prostheses, wide-diameter implants were combined with Frialit-2 implants of other widths (3.8 mm, 4.5 mm).

Implant Surgery and Prosthetic Treatment

A total of 121 wide endosseous implants were placed, 74 in the maxilla and 47 in the mandible. Step screws (n = 108) and step cylinders (n = 13) of varying lengths were used and placed in immediate-placement (n = 6), delayed–immediate placement (6 to 8 weeks after extraction; n = 22), or late-implantation (n = 93) protocols. All implants were placed using a 2-stage procedure with an intended healing time of either 3 or 6 months (3 for the mandible, 6 for the maxilla). In patients with bone defects or incongruence between the implant and the implant bed, augmentation using bone replacement material (Bio-Oss; Geistlich, Wolhausen, Switzerland) and, if necessary, a resorbable membrane (Bio-Gide; Geistlich) was performed. In maxillae with vertical deficits in the posterior region, internal jaw augmentation (sinus lift, lateral approach) with a mixture of autologous bone and Bio-Oss was used to allow placement of implants with an adequate crown-to-implant ratio (≥ 1.0). In patients who underwent augmentation, an additional healing time of 4 to 6 months was allowed, depending on the extent of the initial defect.

Exposure was followed by a 2- to 4-week healing period before prosthetic restoration was started. Prosthetic treatment included single tooth prostheses, fixed and removable partial dentures, and fixed complete prostheses using either gold alloy or titanium frameworks.

Follow-up Examination

All patients included were part of a regular recall program. During the first year, they were evaluated at intervals of 3 months; subsequently, they were evaluated at 6-month intervals. Patients were evaluated on the Plaque Index and the Bleeding Index (on which implants were scored from 0 to 3).[16–18] Bone resorption was assessed radiographically using the method of Gomez-Roman and associates.[19] The radiographic evaluation included an orthopantomogram and/or single periapical radiographs based on the paralleling technique. For this purpose, the initial postoperative radiograph was compared with the most recent one. Mesial, distal, lingual, and buccal pocket depths were measured using a calibrated periodontal probe (Hu-Friedy, Chicago, IL). Implant mobility was measured with the Periotest (Siemens, Munich, Germany)[20] at the abutment close to the implant edge when the prostheses were removed for cleaning or for checking the abutment screws during at least 1 postplacement examination. All clinical data were obtained to evaluate the results of wide-diameter Frialit-2 implants at least 1 year after the completion of prosthetic treatment.

Statistics

The parameters were recorded in a descriptive statistical manner, tabulated, and evaluated. The survival times of the implants and crowns were analyzed in a cumulative life table analysis. Mean values were compared using the Student t test, nonparametric data using the chi-square test. $P < .05$ was used as the statistical significance level.

RESULTS

Table 1 shows the lengths and the locations of the 121 implants placed. A majority of the implants (n = 87) were placed in the molar regions in both maxillae (n = 47) and mandibles (n = 40). Only 12 implants (10%) were shorter than 13 mm, and no implant had a length of less than 10 mm. Most of the "short" 5.5-mm implants placed in the mandibular molar area (n = 8) were used to support fixed partial dentures (Tables 1 and 2), which were also anchored using 3.8-mm-wide or 4.5-mm-wide Frialit-2 implants.

Table 1 Distribution of Implants According to Length and Location

Implant location/ length	No. of implants placed			Survival (%)
	Maxilla	Mandible	Total	
Molar	47 (2)	40 (0)	87 (2)	98
10 mm	2 (0)	8 (0)	10 (0)	100
13 mm	3 (0)	23 (0)	26 (0)	100
15 mm	42 (2)	9 (0)	51 (2)	96
Premolar	11 (0)	7 (0)	18 (0)	100
10 mm	—	2 (0)	2 (0)	100
13 mm	3 (0)	4 (0)	7 (0)	100
15 mm	8 (0)	1 (0)	9 (0)	100
Canine	7 (0)	—	7 (0)	100
15 mm	7 (0)	—	7 (0)	100
Incisor	9 (0)	—	9 (0)	100
13 mm	2 (0)	—	2 (0)	100
15 mm	7 (0)	—	7 (0)	100

Failed implants are shown in parentheses.

Table 2 shows the implant survival rates and the failures according to implant length and the type of prosthetic rehabilitation used. There were no failures among the 104 implants supporting single-tooth restorations or fixed partial restorations during the observation period.

Follow-up ranged from 12 to 114 months, with a mean follow-up time of 41.8 ± 18.5 months. Two maxillary implants lost osseointegration; therefore the overall survival rate was 98.3% (97.3% for maxillary implants and 100% for mandibular implants). Both lost implants had been placed in augmented maxillary posterior regions where sinus lift procedures had been done previously using autogenous bone and Bio-Oss. Both lost implants were replaced by 4.5-mm-wide implants after a healing period of 3 to 6 months. Table 3 shows the life table analysis for the 121 implants.

In 58 of 74 maxillary implants, a sinus lift procedure was performed to achieve sufficient bone height (eg, optimal crown-to-implant ratio > 1.0) for placement of implants in the posterior maxillary regions. Eight of these implants supported single-tooth restorations, 38 supported fixed partial dentures, 7 supported complete dentures, and 5 supported removable dentures. For 33 implants (of which 1 failed), a single-stage sinus lift procedure was used, and for the remaining 25 implants (of which 1 failed), a 2-stage sinus lift procedure was used.

Table 2 Distribution of Implants According to Prosthesis Type and Implant Length

Prosthesis type/implant length	Maxilla		Mandible		Total	
	Placed	Survival rate (%)	Placed	Survival rate (%)	Placed	Survival rate (%)
Single tooth						
10 mm	—	—	1 (0)	100	1 (0)	100
13 mm	3 (0)	100	15 (0)	100	18 (0)	100
15 mm	9 (0)	100	8 (0)	100	17 (0)	100
Total	12 (0)	100	24 (0)	100	36 (0)	100
Fixed partial denture						
10 mm	—	—	10 (0)	100	10 (0)	100
13 mm	6 (0)	100	7 (0)	100	13 (0)	100
15 mm	41 (0)	100	4 (0)	100	45 (0)	100
Total	47 (0)	100	21 (0)	100	68 (0)	100
Fixed complete denture						
13 mm	2 (0)	100	—	—	2 (0)	100
15 mm	7 (1)	85	—	—	7 (1)	85
Total	9 (1)	89	—	—	9 (1)	89
Removable denture						
10 mm	1 (0)	100	—	—	1 (0)	100
13 mm	—	—	2 (0)	100	2 (0)	100
15 mm	5 (1)	80	—	—	5 (1)	80
Total	6 (1)	83	2 (0)	100	8 (1)	87
Total	74 (2)	97	47 (0)	100	121 (2)	98

Failed implants are shown in parentheses.

Table 3 Life Table Analysis Showing Cumulative Survival Rates in the Maxilla and Mandible

	Maxilla			Mandible		
Time period	Implants	Implants not included in time period	CSR (%)	Implants	Implants not included in time period	CSR (%)
Placement to loading	74 (0)	—	100	47 (0)	—	100
Loading to 1 y	72 (2)	—	97.3	47 (0)	—	100
1 to 2 y	56 (0)	16	97.3	35 (0)	12	100
2 to 3 y	43 (0)	13	97.3	26 (0)	9	100
3 to 4 y	33 (0)	10	97.3	20 (0)	6	100
4 to 5 y	29 (0)	4	97.3	17 (0)	3	100
> 5 y	23 (0)	—	97.3	14 (0)	—	100

Failed implants are shown in parentheses.
CSR = cumulative survival rate.

Radiographically detected bone loss, pocket depth, Plaque Index scores, Bleeding Index scores, and Periotest values have been summarized in Tables 4 and 5. Bone resorption did not differ significantly from previously published reports on Frialit-2 implants. The results show satisfactory peri-implant soft tissue conditions, high stability, a low degree of bone resorption, and satisfactory pocket depth. All prostheses were functional throughout the observation period.

One hundred nineteen implants (72 maxillary, 47 mandibular) supporting an overall 108 prosthetic structures (63 maxillary, 45 mandibular) were evaluated at the last examination: the 36 single-tooth restorations and 3 fixed complete prostheses supported by 8 implants in edentulous maxillae; 63 fixed partial dentures (44 in the maxilla and 19 in the mandible) supported by 68 implants; and 6 removable dentures (4 in the maxilla and 2 in the mandible) supported by a combination of implants and bar or ball attachments.

There were no fractures of implants, abutments, or screws. Four single-tooth crowns had to be recemented, and for 5 restorations, porcelain fracture had to be repaired (2 single-tooth restorations and 3 fixed partial dentures). One patient with a complete fixed prosthesis had phonetic problems for more than 6 months after placement of the prosthesis.

Table 4 Mean Peri-implant Bone Resorption, Pocket Depth, and Periotest Values of the Surviving Implants (n = 119)

	Mean ± SD	Range
Bone resorption	1.4 ± 1.2 mm	0.0 to 3.5 mm
Pocket depth	3.4 ± 1.1 mm	1.0 to 5.0 mm
Periotest values	–4.3 ± –3.1	–2.0 to –7.0

Table 5 Plaque Index and Bleeding Index Scores

	Implants	
	n	%
Plaque Index		
0	91	76.5
1	28	23.5
2	0	0.0
3	0	0.0
Bleeding Index		
0	101	84.9
1	18	15.1
2	0	0.0
3	0	0.0

DISCUSSION

Wide-diameter implants were introduced for 2 purposes: placement of implants in bone of poor quality or low quantity and as replacements for failing standard implants.[1–7,11–13] The first studies of wide-diameter implants produced unfavorable results and showed loss rates of 15% and 18%, respectively.[4,13] In a 4-year study of three hundred twenty 5.0-mm-wide implants, Barrachina and coworkers[21] described survival rates of 86% in the maxilla and 93% in the mandible. One of the highest failure rates for wide-diameter implants (18%) was reported by Ivanoff and colleagues.[13] However, the majority of the wide-diameter implants (92%) in the earliest 2 studies had a length of only 6 or 8 mm, and in half of the cases they were used as rescue implants after standard implants had failed.[4,13] No wide-diameter implant with a length of 10 mm or more was lost. Most of the failed wide-diameter implants either showed no osseointegration or were lost during the first 2 years of loading.[13]

In contrast, satisfactory results have also been described for wide-diameter implants. Most of these studies involved Brånemark System implants.[1,7,12,22] Bahat and Handelsman,[1] Renouard and associates,[7] Friberg and coworkers,[12] and Davarpanah and colleagues[22] described success rates of 93% to 98% for wide-diameter implants used to support single-tooth restorations and partial dentures. The 3i wide-diameter implant (5-mm-wide and 6-mm-wide; Implant Innovations, Palm Beach Gardens, FL), which is similar to the Brånemark System implant, was used by Graves and associates.[2] The 226 wide 3i implants placed had a survival rate of 96% over a 2-year follow-up period, without any implant losses during the loading phase.[2] Favorable results have also been reported for Screw-Vent implants[14] with a diameter of 4.7 mm—significantly larger than standard implants but narrower than those used in this study or in studies of Brånemark System implants.[1,4,5] With their smaller diameter of 4.7 mm, the Screw-Vent implants can be used in the premolar regions more frequently, although some authors[2,5,7,9,12] have advised against the use of wide-diameter implants in the premolar region.

The results of the present study also show that wide-diameter Frialit-2 implants can be used in the premolar region only rarely. Preference of the molar region is an obvious consequence of the peri-implant bone situation in the premolar region, which is frequently inadequate for a 5.5-mm implant. In this respect the present authors agree with the opinions of Handelsman[6] and Friberg and associates,[12] who name the molar region as the primary site for wide-diameter implants.

The results presented suggest that no implant losses were encountered for prolonged periods. This high survival rate may be attributed to at least 2 factors: first, avoidance of the use of short wide-diameter implants (6 to 8 mm), and, second, the placement of wide-diameter implants by primary intention. Wide-diameter implants have achieved the best results when used to support single-tooth restorations with satisfactory crown-to-implant ratio and when used with fixed partial prostheses.[12,16,22,23] When used as single-tooth replacements, wide-diameter implants may provide for an esthetically satisfactory emergence profile and also facilitate easy and safe oral hygiene in locations that are otherwise difficult to access and to clean.[3,16,23]

No implant losses were encountered in the mandible. Although use in support of fixed partial prostheses in the mandible required the placement of shorter (10 mm) wide-diameter implants, a high survival rate was also seen with these shorter implants,[24–27] in contrast to reports of lower cumulative survival rates in the mandible.[4,13] This survival rate may be explained primarily by the fact that the implants were not placed as rescue implants but were planned for placement, as also described by Friberg and colleagues.[12]

Implant losses were limited to the maxilla, which is in agreement with the overall majority of clinical follow-up studies of screw-type implants.[1,25–27] In the maxilla, an internal sinus augmentation was used where needed if possible, so as to provide for maximum height in addition to optimum width.[27,28] However, even in such cases, wide-diameter implants were not used as rescue implants, but were rather placed by primary intention to provide for a maximum implant surface. The 2 losses seen in the augmented maxillary posterior region are without adequate explanation, although the augmented bone showed reduced bone density. In both cases, the same procedure was simultaneously done in the contralateral jaw and resulted in satisfactory osseointegration.[28,29] With 5.5-mm-wide implants, reimplantation following implant loss is only possible after prolonged healing time, which can be considered a drawback of using implants of this size. Although 6.5-mm implants are also available from the manufacturer, such implants could not be used in either of the 2 cases; thus, renewed implantation was only possible after adequate reossification.

In addition to the primary indication for use and appropriate crown-to-implant ratio,[24] long-term success is affected by the prosthetic use. While single-tooth implants have shown excellent overall results,[16,23,30] a maximum implant diameter provides added benefits. In both the maxilla and the mandible, wide-diameter implants may provide additional support for removable partial dentures.[7,11,23–26] However, the use of wide-diameter implants for anchorage of removable partial dentures still requires critical evaluation to assess whether wide-diameter implants affect the suprastructure design. Using standard-diameter implants, the suprastructure may frequently be better designed and more comfortable for the patient.

Regarding the characteristics of peri-implant parameters such as Plaque Index, Bleeding Index, pocket depth, and stability, no differences were found between the wide-diameter implants and standard or smaller diameter implants.[15,18] The minor peri-implant bone loss encountered must be considered as a development within the biologic bandwidth and was not significantly different than that seen with other wide-diameter implants.[12–14]

CONCLUSION

The present study showed that high survival rates can be obtained after prosthetic treatment with 5.5-mm-wide implants in a variety of clinical situations. After being loaded for a mean of 41.8 ± 18.5 months, the implants had an overall survival rate of 98.3%; the cumulative survival rates were 97.3% in the maxilla and 100% in the mandible. Wide-diameter implants used for single-tooth restorations and as abutments for fixed partial prostheses showed satisfactory results (100%). As beneficial as the wide-diameter implants may have been in this study, anatomic and prosthodontic limitations for their use were identified.

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