Turned Brånemark System® Implants in Wide and Narrow Edentulous Maxillae: A Retrospective Clinical Study

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ABSTRACT

Background: The available jawbone volume is regarded as one of the most important factors when assessing the prognosis of oral implants in the rehabilitation of the edentulous maxilla.

Purpose: The aim of the current investigation was to retrospectively evaluate and compare the outcome of implants placed in edentulous maxillae with either wide or narrow jaw shapes. The marginal bone loss and implant cumulative survival rates (CSRs) were calculated and analyzed with special reference to smoking habits.

Materials and Methods: The study included 75 individuals with edentulous maxillae, of which 33 patients exhibited wide (group A) and 42 patients exhibited narrow jaw shapes (group B). A total of 506 turned Brånemark System® (Nobel Biocare AB, Göteborg, Sweden) implants were inserted (226 in group A and 279 in group B) and followed clinically up to 7 years. Smoking habits were recorded. Radiographs were obtained at connection of prostheses, and at the 1- and 5-year follow-up visit. The marginal bone loss was calculated for the groups and analyzed using *t*-test.

Results: Twenty-eight implants were lost during the study period, revealing implant CSRs at 7 years of 94.6% (11/226) and 93.6% (17/279) for wide and narrow crests, respectively. No difference in marginal bone loss was seen between the two groups, although a trend toward more bone loss was recorded for patients with wide crests. Smoking habits were more common in group A (45%) than in group B (31%). During the first year of function, smokers lost significantly more marginal bone than nonsmokers ($p = .0447$), albeit this difference did not prevail ($p > .05$) at the end of the study period.

Conclusions: The implant CSRs at 7 years were equally good for the two groups of patients with various jaw shapes. Initially, smokers showed significantly more marginal bone loss than nonsmokers.

KEY WORDS: edentulous maxilla, marginal bone loss, oral implants, smoking habits, wide/narrow jaws

The use of oral implants in the rehabilitation of total and partial edentulism has shown excellent results over the years.[1–4] Factors of importance for the predictable long-term prognosis have thereby been proposed, such as available jawbone volume,[5–7] jawbone quality,[5–8] and smoking habits.[9–11] Minor bone volumes together with soft bone textures have often been regarded as causative of implant failures, and implant success/survival rates of maxillae have thus frequently been lower than those reported for mandibles.[1,3,12,13] Meta-analysis on the influence of smoking on osseointegrated implants has, as well, shown a significant risk for failures and especially for those located in the maxilla.[11] The main reasons for judging implants as failures are either that they are completely mobile or afflicted with excessive marginal bone loss.[14] A possible implication of the latter may be that smokers show more resorption of marginal bone around functioning implants as compared to nonsmokers.

The aim of the present retrospective follow-up study was to compare the implant survival and marginal bone loss in two groups of patients with wide and narrow edentulous alveolar crests in the maxillae, and with special reference to smokers and nonsmokers.

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MATERIALS AND METHODS

The present study covers edentulous patients consecutively provided with osseointegrated implants in the edentulous maxilla by one oral surgeon between January 1993 and December 1997 (The Brånemark Clinic, Public Dental Health Service, Göteborg, Sweden). Preoperatively, the surgeon characterized the edentulous maxillary crest based on its shape in the marginal third as "wide," "medium," or "narrow," and of special interest in the present report were the patients with either "wide" or "narrow" crests (Figures 1 and 2). Height reduction was inevitable before site preparation in narrow crests, and most frequently, the implants could be observed underneath a thin layer of buccal bone. Wide jaws did not require any height reduction, and the implants were encompassed with bone of good volume. Thus, all patients denoted with these crests were included and the present investigation comprised 75 patients, divided into two groups. Group A, denoted with wide crests, consisted of 33 patients, where five of the patients were females. Mean age at implant placement was 62.5 years (range: 20 to 80 years). Group B (with narrow crests) consisted of 42 patients where 31 patients were females. In this group, mean age at implant surgery was 65.1 years (range: 42 to 87 years). Distribution of males and females was significant between the two groups ($p < .05$).

Figure 1 Tomogram of anterior maxilla showing the wide crest (representing group A patients).

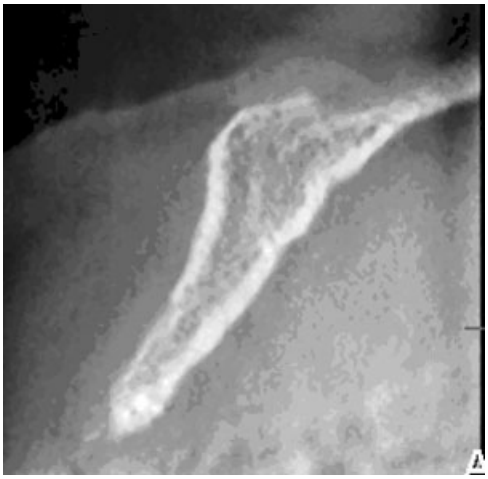

Figure 2 Tomogram of anterior maxilla showing the narrow crest (representing group B patients).

Before surgery, data were retrieved on time of tooth extraction and time of edentulism as well as information on medical history and general health problems (Table 1). Smoking habits were registered for all but one patient.

At the time of implant placement, the jaw and not the individual implant site was assigned quantity and quality scores, as well as shape of the marginal third of the crest (see Figures 1 and 2). Bone shape was judged from preoperative radiographs, and bone quality from the subjective perception during drilling according to the classification proposed by Lekholm and Zarb[15] (Table 2).

A standard implant insertion procedure[16] without grafting was accomplished in all patients, despite the narrow jaw shape in group B patients. A total of 506 Brånemark System® (Nobel Biocare AB, Göteborg,

TABLE 1 Distribution of Numbers of Patients Recorded with General Health Disorders

Diagnosis	Wide Crest ($n = 33$)	Narrow Crest ($n = 42$)
Cardiac and vascular diseases	8	9
Rheumatoid arthritis	1	1
Respiratory disease	3	1
Hyperthyroidism	1	1
Peptic ulcer	0	1
Hand–Schuller–Christian disease	1	0
Smokers	45%*	31%

*Missing data in one patient.
Numbers of patients (n) are given within brackets.

TABLE 2 Distribution of Implants in Various Bone Quality and Quantity

	Bone Quantity					
Bone Quality	A	B	C	D	E	Total
Group A (wide)	Number of Patients					
1	0	0	0	0	0	0
2	0	13	6	6	0	25
3	0	3	3	1	0	7
4	0	1	0	0	0	1
Total	0	17	9	7	0	33
Group B (narrow)						
1	0	0	0	0	0	0
2	0	1	5	5	1	12
3	0	4	7	5	0	16
4	0	1	7	6	0	14
Total	0	6	19	16	1	42

Sweden) implants with turned surfaces and of various designs were inserted, of which 226 implants were placed in wide and 279 implants in narrow jaws. The distributions of implants with regard to design, length, and diameter in groups A and B are shown in Table 3.

Intraoral radiographs were obtained at connection of prosthetic constructions (baseline) and at 1 and 5 years of follow-up. Marginal bone resorption was evaluated mesially and distally in relation to the fixture/abutment junction of the implant, and a mean value was calculated for each implant at baseline and after 1 and 5 years of follow-up (Table 4).

Statistical Analyses

Life tables of implant cumulative survival rates (CSRs) were calculated for the two groups of patients (Table 5). Chi-square tests were used to compare distributions between the groups. *t*-test was used to compare mean bone loss measurements between the groups. Fischer's nonparametric permutation test[17] was used in unadjusted analysis to test the differences between the two groups, where tested variables were age, sex, disease, medication, and number of implants. All tests were two-tailed and conducted at 5% significance level.

RESULTS

The mean time periods of maxillary edentulism were for group A 1.5 years (range: 4 months to 10 years) and for group B 5.0 years (range: 4 months to 40 years), respectively. Smoking was more common in group A (45%) than in group B (31%), but not reaching a significant difference in distribution ($p > .05$). When accounting for the number of patients in each group, general health disorders were more frequently reported in group A than in group B ($p > .05$). In contrast to this, the number of patients with the soft quality 4 bone showed an overrepresentation in group B (14 patients), as compared to one patient in group A ($p < .01$).

Various lengths of implants were utilized, and the numbers of long (≥10 mm or longer) implants were 200 and 233 for groups A and B, respectively, while more short implants (≤8.5 mm) were placed in group B, that is, 46 versus 26 for group A (see Table 3).

A total of 28 implants were recorded as failures and removed during the follow-up period. Eleven of these failures were in group A and 17 in group B ($p > .05$). The distribution of failures in group A showed that four implants were ≤8.5 mm (4/26; 15.4%) and seven were >8.5 mm (7/200; 3.5%), while the corresponding figures for group B were nine (9/46; 19.6%) and eight (8/233; 3.4%), respectively (see Table 3).

Ninety-eight implants were placed in the 15 jaws assigned the quality 4 score and six of these were lost during the study period. Assuming that all 98 sites were of quality 4, the failure rate in such bone was 6.1%.

Seven and 10 patients were involved with implant losses in groups A and B, respectively. Clusters of failures were noticed in both groups. Thus, three patients were recorded with 7 out of 11 implant failures (64%) in group A, and three patients were recorded with 10 out of 17 failures (59%) in group B. With regard to specific jaw regions, failures were equally distributed in the two groups. In group A, five implants were lost in premolar/molar regions and six implants in incisor/canine regions. The corresponding figures for group B were eight and nine, respectively. Of the 28 implants that failed, 18 were lost in smokers.

Overall, 7-year implant CSRs were 94.6 and 93.6%, respectively (see Table 4).

Patients with wide crests, as compared to the narrow ones, showed a trend of more marginal bone loss throughout the study period (see Table 5). This reached a significant level between the first and fifth years of follow-up ($p < .05$), when, significantly, more implants ($p < .001$) in wide crests showed bone loss (see Table 5; >0 mm).

TABLE 3 Distribution of Implants Based on Design, Length, and Diameter

	6 mm	7 mm	8.5 mm	10 mm	11.5 mm	12 mm	13 mm	15 mm	18 mm	20 mm	Total
Group A											
Standard 3.75 mm		1	10 (1)	11 (1)			20 (1)	23	15	3	83 (3)
Standard diameter 4 mm		8 (2)	1	16			9	12	2		48 (2)
Standard diameter 5 mm	6 (1)			2 (1)		4					12 (2)
Mk II 3.75 mm				13	3 (1)		16 (3)	21	20		73 (4)
Mk II 4 mm					1						1
Mk III 3.75 mm				1			4	2			7
Old self-tapping							2				2
Total	6 (1)	9 (2)	11 (1)	43 (2)	4 (1)	4	51 (4)	58	37	3	226 (11)
Group B											
Standard 3.75 mm		13 (6)	16 (1)	20			27	13	7		96 (7)
Standard 4 mm		10 (2)	2	13 (2)			10	9 (1)	5 (1)		49 (6)
Standard 5 mm	5										5
Mk II 3.75 mm				38 (1)	5		42 (2)	21	3		109 (3)
Mk III 3.75 mm				4 (1)			4				8 (1)
Old self-tapping				4			5	2			11
Narrow platform								1			1
Total	5	23 (8)	18 (1)	79 (4)	5		88 (2)	46 (1)	15 (1)		279 (17)

Failed implants within in parentheses.

TABLE 4 Life Tables with Implant Cumulative Survival Rates (CSRs) in Wide (Group A) and Narrow (Group B) Crests

Group A	Implants	Failed	Withdrawn	CSR (%)
Placement – abutment	226	3	14	98.7
Abutment – 1 year	209	0	0	98.7
1–2 years	209	2	17	97.7
2–3 years	190	1	3	97.2
3–4 years	186	1	0	96.7
4–5 years	185	0	0	96.7
5–6 years	185	3	0	95.1
6–7 years	182	1	0	94.6
7 years	181			
Group B	**Implants**	**Failed**	**Withdrawn**	**CSR (%)**
Placement – abutment	279	7	0	97.5
Abutment – 1 year	272	3	14	96.4
1–2 years	255	4	26	94.9
2–3 years	225	0	0	94.9
3–4 years	225	0	0	94.9
4–5 years	225	0	8	94.9
5–6 years	217	3	0	93.6
6–7 years	214	0	5	93.6
7 years	209			

TABLE 5 Mean Marginal Bone Resorption at the 1- and 5-year Follow-Up for Implants Placed in Wide (Group A) and Narrow (Group B) Crests

	Follow-Up Periods					
	Narrow Crest			Wide Crest		
	0–1 Year	0–5 Years	1–5 Years	0–1 Year	0–5 Years	1–5 Years
Patients	38	24	24	27	22	22
Implants	246	160	160	177	150	150
	Mean Patient Bone Loss in mm					
Mean	0.29	0.64	0.15	0.47	0.74	0.51
Standard deviation	0.42	0.55	0.42	0.57	0.67	0.65
Bone loss in mm	Number of Implants (%)					
0	158 (64)	62 (39)	117 (73)	109 (62)	52 (35)	78 (52)
>0	88 (36)	98 (61)	43 (27)	68 (38)	98 (65)	72 (48)
0.1–1.4	74	70	35	50	71	54
1.5–1.7	4	9	4	9	12	9
1.8–2.2	6	13	3	2	5	4
≥2.3	4	6	1	7	10	5

TABLE 6 Mean Marginal Bone Resorption at the 1- and 5-Year Follow-Up for Implants with Regard to Smokers and Nonsmokers in Wide (Group A) Crests Patients

	Follow-Up Periods of Wide Crest Patients					
	Smokers			Nonsmokers		
	0–1 Year	0–5 Years	1–5 Years	0–1 Year	0–5 Years	1–5 Years
Patients	13	8	8	12	13	13
Implants	79	52	52	82	90	90
	Mean Patient Bone Loss in mm					
Mean	0.66	0.78	0.56	0.31	0.68	0.42
Standard deviation	0.33	0.49	0.46	0.50	0.78	0.75
Bone loss in mm	Number of Implants (%)					
0	38 (48)	19 (37)	25 (48)	58 (70)	33 (37)	53 (59)
>0	41 (52)	33 (63)	27 (52)	24 (30)	57 (63)	37 (41)
0.1–1.4	26	22	24	21	44	25
1.5–1.7	7	6	2	2	3	4
1.8–2.2	2	1	0	0	4	4
≥2.3	6	4	1	1	6	4

In general, smokers lost significantly more marginal bone ($p < .05$) during the first year of function as compared to nonsmokers, a difference that did not prevail during the later study period. This difference was significant ($p < .05$) in the wide crest group (Table 6; 0 to 1 year), but not ($p > .05$) in the narrow crest group (Table 7).

The analysis conducted to adjust for confounding variables, such as age, sex, disease, medication, and number of implants showed no relation to the outcome.

DISCUSSION

In the current investigation, grouping of patients was conducted according to the resorption state of the maxillae, that is, wide and narrow jaw shapes. In the classification study of the edentulous jaws, Cawood and Howell[18] claimed that the pattern of bone loss in the anterior and posterior maxilla is both horizontal (from the labial aspect) and vertical. Hence, the more advanced resorption found in group B patients (narrow crests) may be explained by the longer time period these patients were without teeth; that is, as a mean 5.0 versus 1.5 years.

The trend of more marginal bone loss around implants placed in wide crests may be coincidental or a result of more frequent smoking habits in this group. The impact on smoking on marginal bone loss was evaluated by Nitzan and colleagues,[19] who examined records of 161 patients treated with a total of 646 implants. Lost implants were few despite heavy smoking in some patients. The radiographic success rate, though, was significantly lower for smokers than nonsmokers, that is, a higher incidence of marginal bone loss was seen in the smoking group and this was more pronounced in the maxilla.

A total of 17 patients (22.7%) were involved with 28 implant failures, of which six individuals were responsible for 17 failures (60.8%). The fact that few patients cause the majority of problems; that is, the cluster phenomenon, has been frequently reported by others.[20–22] The two patients who lost six and three implants, respectively, were both heavy smokers.

The more frequent use of short implants (≤8.5 mm) in group B patients is an expression for the narrow jaw shape and the necessity of reducing the bone height before inserting the implants. The majority of failures in

TABLE 7 Mean Marginal Bone Resorption at the 1- and 5-Year Follow-Up for Implants with Regard to Smokers and Nonsmokers in Narrow Crest (Group A) Patients

	Follow-Up Periods of Narrow Crest Patients					
	Smokers			Nonsmokers		
	0–1 Year	0–5 Years	1–5 Years	0–1 Year	0–5 Years	1–5 Years
Patients	12	8	8	26	16	16
Implants	80	56	56	166	103	103
	Mean Patient Bone Loss in mm					
Mean	0.38	0.74	0.22	0.25	0.58	0.12
Standard deviation	0.37	0.48	0.53	0.45	0.60	0.38
Bone loss in mm	Number of Implants (%)					
0	50 (63)	21 (38)	42 (75)	108 (65)	41 (40)	74 (72)
>0	30 (37)	35 (62)	14 (25)	58 (35)	62 (60)	29 (18)
0.1–1.4	25	25	8	49	44	27
1.5–1.7	0	1	3	4	8	1
1.8–2.2	1	5	2	1	8	1
≥2.3	4	4	1	4	2	0

group B patients (9/17) were of the short implant design and six of these were placed in quality 4 bone. This emphasizes the rather deleterious combination of a small bone volume and a soft bone texture, which has also been pointed out by others.[5–8] In the investigation by Renouard and Nisand,[23] it was claimed though, that short implants (≤8.5 mm) in posterior maxillae can be most successful with a 2-year survival of 94.6%. The same authors[24] have, as well, most ambitiously reviewed the literature on the impact of implant length and diameter on survival rates. Here, they state that a surgical technique adapted to the actual bone site, the use of textured-surfaced implants, and modified case selection may reveal survival rates comparable to those seen for the longer implants. In the current study, an adapted site preparation technique was used, albeit all patients were consecutively treated with turned-surfaced implants. The placement of 46 and 26 short implants in groups B and A patients and with failure rates at 7 years of 19.6 and 15.4%, respectively, leaves a great deal to be desired. However, these figures should be compared with, as correctly pointed out by Renouard and Nisand,[24] implant survival rates of sinus inlay and crestal onlay grafting techniques, which is the only alternative if one chooses to exclude short implants.

At the time of implant placement, the jaw and not the individual site was classified according to the proposed quality and quantity criteria by Lekholm and Zarb.[15] Hence, some individual sites may have harbored bone of higher or lower bone density. Assuming that the 15 quality 4 scored jaws had homogenous bone, the 98 implants placed in those jaws were all facing the soft bone texture. The loss of six implants in such bone (6.1%) is in line with other observations[25,26] and in bright contrast to the high 5-year implant failure rates in quality 4 bone presented by Jaffin and Berman.[27]

CONCLUSIONS

Implant treatment in edentulous maxillae with wide and narrow jaw shapes revealed at 7 years of follow-up equally good CSRs of 94.6 and 93.6%, respectively. Patients with wide crests tended to lose more marginal bone than those with narrow crests throughout the study. Initially, that is, during the first year of function, smokers showed significantly more marginal bone loss

than nonsmokers, a difference that did not prevail during the remaining study period.

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