

Safe and Effective Alternatives to Sinus Elevation in the Atrophic Posterior Maxilla

Part I—A Masters Thesis

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_Maxillary sinus elevation and bone augmentation are acceptable techniques that may provide sufficient bone quantity and quality for implant support in the posterior atrophic maxilla (Wallace SS et al. 2003). Yet, given the morbidity risk plus cost and time consuming effects, these techniques are to be reconsidered. Simpler and safer protocols are therefore required for the posterior maxilla where bone resorption, deficient posterior alveolar ridge, and increased pneumatization of the sinus all result in a minimal hard tissue bed thus render implant placement difficult (Frank R et al. 2005).

N = 630 ITI	35 (6 mm)	141 (8 mm)	454 (10–16 mm)
Survival rates	94.3%	99%	97.4%

Table 1_ Study of short Straumann implants versus long implants.

_1. Introduction

The present thesis seeks: (1) to show that applying to specific alternative implantation techniques in the atrophic posterior maxilla is (a) safer than, and (b) as effective as, maxillary sinus elevation and bone augmentation techniques; and (2) to address simplified implantation protocols (Brånemark PI et al. 1995).

The examined alternative techniques are set out in four sections respectively: Short Implant, Tilted Implant, Tuberosity Implant and Disk Implant.

Section one highlights the insertion of short implants in less than 10 mm bone height under the sinus provided they are well anchored in the residual bone (Deporter D et al. 2000). Section two draws attention to the insertion of (longer) tilted implants in the remote available bone avoiding anatomical vital structures such as arteries, nerves and sinus antrum (Pierrisnard L et

Survival Time (mo) of 6 x 5.7 mm Implants vs. non 6 x 5.7 mm

Time	N° of 6 x 5.7 mm		N° of non 6 x 5.7 mm		p
	Implants at risk	Survival (%)	Implants at risk	Survival (%)	
0	45	100	124	100	
12	NA				
24	31	92.2 ±4	87	95.2 ±2	78
36	16	92.2 ±4	83	94.1 ±2	NA
48	12	92.2 ±4	39	92.4 ±3	NA
60	7	92.2 ±4	29	92.4 ±3	NA
	3	92.2 ±4	19	92.4 ±3	NA

NA = not applicable; P= statistically difference

Table 2_ Study with short Bicon implants.

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al. 2003). Section three emphasizes the insertion of implants in the maxillary tuberosity to benefit from available bone usually discarded. In each of the above sections studies are displayed with the aim of examining the results in terms of safety and effectiveness and thus verifying the comparability to the sinus elevation and bone grafting procedures. Section four throws light on Disk Implant that tries to adapt the shape of the implant to the shape of the bone rather than the way around (Ihde S. 2007). It is early, however, to verify the comparability of such attempt due to shortage of studies.

2. Aim

The reason of examining specific alternatives to sinus elevation and bone augmentation in the atrophic posterior maxilla is to verify whether they are performed with less time consumption, less cost, and less invasive surgeries yet still with comparable and satisfactory results. Examined alternatives in this thesis are tilted implant, short implant, tuberosity implant and disk implant. The aim is to report long term survival rates of these alternatives and to show that applying them is safer than, and as effective as, maxillary sinus elevation and bone augmentation.

3. Materials and Methods

3.1 Short Implants

- (a) A study involved 630 Straumann implants [35 (6 mm long), 141 (8 mm) and 454 (10–16 mm)] placed in 264 patients within 1994 and 2003. Two-year survival rates were comparable between short (6 mm), (8 mm), and longer (10–16 mm) implants in this population (Table 1; Arlin ML. 2006).
- (b) A 98.9% survival rate was the result of a retrospective evaluation of 273 consecutive posterior partially edentulous patients treated with 745 implants (7–9 mm) supporting 338 restorations over 1–5 years period (Misch CE et al. 2006).
- (c) 129 patients (68 women, 61 men) were treated over a 4-year-period with fixed prostheses supported by 265 different-sized implants: 154 (10 mm) standard and 111 (8 mm) short. Survival rates were 97.9% for 10 mm and 97.1% for 8 mm (Romeo et al. 2006).
- (d) For 293 patients treated with 532 short implants (2001–2002), the overall survival rates were 99.2% and 98.7% for the implant- and subject-based analysis, respectively (Anitua E et al. 2008).
- (e) A retrospective study involved 237 patients treated with 408 short Brånemark implants: 131 (7 mm) and 277 (8.5 mm) with final fixed prostheses delivered 4 to 6 months later. Cumulative survival rates after 5 years were 96.2% (126/7 mm) and 97.1% (269/8.5 mm) (Malo P et al. 2007).
- (f) A cohort study over 5 years involved a total of 62 implants: 28 (6 x 5.7 mm) test group and 34 (non 6 x 5.7 mm) control group non-short (8–14 mm). The survival rates over 5 years were 100% for the test group and 96.8% for the control group. No significant difference was found between the two groups regarding mean changes of radiographic bone levels (Caterina V et al. 2008).
- (g) A study on Bicon implants (6 x 5.7 mm) (Fig. 1) reports a survival rate comparable to non-6 x 5.7 mm implants. 172 implants were used 34.3% of which were placed in the posterior maxilla. Survival rates were 92.2% $\pm$ 2% for 6 x 5.7 mm and 95.2% $\pm$ 2% for non-6 x 5.7 mm implants. The comparable survival rates estimates for 6 x 5.7 mm and non 6 x 5.7 mm suggest that 6 x 5.7 mm implants can bear a functional load after placement. The results are consistent with the findings of Vehement and colleagues in their study (Table 2) (Gentile MA et al. 2005).
- (h) A study compared wide diameter short implants (WSI) (6 mm in ϕ x 5.7 mm in length) (Fig. 2) to narrow and long implants (NLI) (3.5 mm x 11 mm) in various bone densities with finite element analysis (FEA) applied. The results showed that the WSI demonstrated better biomechanical force distribution



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Fig. 1 Short Bicon (6 x 5.7 mm) implants in the posterior maxilla.

Fig. 2 Radiographs of short wide implants (Nobel Biocare) (Courtesy of Prof. Barakat N. Lebanese Univ.).



Fig. 1



Fig. 2

As regards changes in marginal bone level, the difference is statistically significant. The study shows that the marginal bone resorption is low for the tilted implants as recorded

than the NLI when horizontal forces were exerted. WSI may be considered for implantation in anatomically compromised regions and of poor bone quality (Bozkaya D et al. 2004).

- (i) Various studies performed by different authors show 95.8% mean survival rates as illustrated in (Table 3) (Gentile et al. 2005).

below in (Table 5) (Calandriello R et al. 2005).

The reason behind the lower bone resorption for the tilted implants may be related to the position of the implant neck relative to the bone crest. Mesially, the neck is positioned supracrestally, whereas distally it is positioned subcrestally, thus resulting in a favorable tissue seal (Hermann JS et al. 2000).

3.2 Tilted Implants

- (a) Eighteen patients (mean age 64) were treated with 60 implants between January 2001 and December 2003, and followed up within a range of one to four years. Survival rates were 97.0% for axial implants (1 failure out of 33) and 96.3% for tilted implants (1 failure out of 27). The cumulative implant survival rates were 96.7%. The study shows no statistical differences in primary stability between tilted and axial implants (Table 4) (Roos J et al. 1997).

- (b) A further study involved 25 patients rehabilitated with 29 partial fixed prosthesis supported by 101 Brånemark Implants: 59 installed in axial direction and 42 installed in tilted direction. Patients were followed up within an average of 37 months. Success rates were 91.3% for axial implants and 95.2% for tilted implants. The cumulative success rate was 93.1% after 5 years. The study shows no statistical difference in pri-

Table 3 Various studies about short implants.

Author	N of yrs.	Implant brand	Length of implants	Survival rate
Bruggenkate 1998	6 yrs.	Straumann	6 mm	94 %
Friberg et al. 2000	5 yrs.	Brånemark	short	95.5 %
Davarpanah et al. 2001	3 yrs.	Osseotite 3i	short	98.45 %
Fugazzotto 2008	7 yrs.		7 to 9 mm	95.1 %

mary stability between tilted and axial implants (Table 6; Carlos A et al. 2001).

Tilted implants show bone loss of 0.14 mm during the first year of loading with minimal changes observed in the marginal bone height. During the first 60 months of loading, the mean bone loss was 1.21mm for tilted implants and 0.92mm for axial implants. Measurements of periosteal variations were not affected by the degree of inclination in respect to the remaining bone. The study shows no significant differences between distal and mesial marginal bone level of tilted and axial implants (Tables 7, 8) (Carlos A et al. 2001).

(c) Another study included 19 patients (6 men and 13 women) with severely resorbed edentulous maxillae (CL IV, CLV) who were treated with tilted implants and fixed dental prostheses 8–12 years previously. In this study, posterior implants were tilted antero-posteriorly more than 30 degrees. The study shows that one man lost one implant whereas one woman lost two implants. No gender difference in the success rate was observed: 97.05% for men and 97.10% for women (Annika R et al. 2007).

The study also shows that the overall success rate of the implants after 8 to 12 years was 97%. Indeed, radiographic examination after this

period revealed bone resorption in 10% of the remaining 100 implants. The mean bone loss for 5 patients was 1.2 mm compared to the immediate postoperative radiographic findings, whereas no bone loss was observed for the other 14 patients according to the criteria of Albrektsson et al. (1mm during the first year after loading and 0.2 mm each thereafter (Albrektsson T et al. 1986).

3.3 Tuberosity implants

Several studies were performed to examine the safety and effectiveness of implantation in the maxillary tuberosity (Table 9)

Implant	Mean value, Ncm	SD, Ncm
Axial (n = 32)	48.1	± 28.3
Tilted (n = 26)	41.9	± 27.5

Table 4_Insertion torque of axial and tilted implants of survival implants.

Implant	6 months	1 year
Axial	0.63 ± 0.86 mm	0.82 ± 0.86 mm
Tilted	0.54 ± 0.74 mm	0.34 ± 0.76 mm

Table 5_Changes in the marginal bone level.

Follow up Time (yr)	Number of Implants				Success Rate	
	Beginning of Period	Drop out	Failed	Surviving	During period (%)	Cumulative (%)
Tilted at placement	42	1	0	0	100	100
0–1	41	0	0	2	95.2	95.2
1–2	27	2	0	0	100	95.2
2–3	25	1	0	0	100	95.2
3–4	17	2	0	0	100	95.2
4–5	13	2	0	0	100	95.2
5–6	12	2	0	0	100	95.2
6–7	9	1	0	0	100	95.2
Axial at placement	59	2	2	1	95.0	95.0
0–1	54	0	0	2	96.3	91.3
1–2	37	5	0	0	100	91.3
2–3	31	3	0	0	100	91.3
3–4	19	3	0	0	100	91.3
4–5	15	3	0	0	100	91.3
5–6	13	3	0	0	100	91.3
6–7	8	1	0	0	100	91.3

Table 6_Implant success rate for tilted and axial implants.

- (a) 72 Brånemark implants were inserted with an average follow up of 21.4 months; the results showed 93 % success rate (Bahat O. 1992).
- (b) 65 implants were inserted with a follow up of 4 years; the results showed 95 % success.
- (c) 42 implants inserted in the posterior maxilla 29 of which in the tuberosity were followed up annually; only 1 of the 42 implants was lost at the second stage surgery (Venturelli A. 1996).

3.4 Disk Implants

Over a 48 months period, 627 laterally inserted disk implants were placed in 72 consecutive patients with completely edentulous maxillae using an immediate loading protocol. The postrestorative follow-up of these patients ranged from 6 to 48 months. 98% of the implants were radiologically and clinically osseointegrated (Scortecchi G. 1999).

	0–1 years	1–2 years	2–3 years	3–4 years	4–5 years	Total
Tilted n						
MBL (mm)	40	25	24	17	11	
Mesial (SD)	0.51 (0.39)	0.31 (0.35)	0.21 (0.37)	0.09 (0.17)	0.07 (0.17)	1.19
Distal (SD)	0.64 (0.39)	0.26 (0.36)	0.17 (0.26)	0.06 (0.16)	0.09 (0.17)	1.22
Mean (SD)	0.57 (0.50)	0.29 (0.32)	0.19 (0.28)	0.08 (0.11)	0.08 (0.12)	1.21
Axial n						
MBL (mm)	53	32	28	16	12	
Mesial (SD)	0.43 (0.50)	0.20 (0.20)	0.10 (0.13)	0.06 (0.10)	0.06 (0.10)	0.85
Distal (SD)	0.43 (0.44)	0.22 (0.28)	0.14 (0.13)	0.06 (0.08)	0.11 (0.10)	0.96
Mean (SD)	0.43 (0.45)	0.23 (0.28)	0.12 (0.10)	0.06 (0.06)	0.08 (0.09)	0.92
Manova test	p > .40	p > .14	p > .14	p > .55	p > .86	

Table 7 Marginal bone loss of tilted and axial implants during follow-up.

Check-up	Tilted Implants	Axial Implants
At placement	-2.62 (-2.97)	-3.57 (-1.88)
First year	-3.54 (-1.47)	-4.05 (-1.54)
Second year	-4.25 (-1.15)	-4.37 (-1.10)
Third year	-4.38 (-1.10)	-4.36 (-1.19)
Fourth year	-4.76 (-1.20)	-5.10 (-0.74)
Fifth year	-4.73 (-1.27)	-5.00 (-0.85)

Table 8 Variations of mean Periotest (PTV) values of tilted and axial implants depending on time.

Bahat O 1992	72 impl.	21.4 mo	93%
Khayat P et al	65 impl.	48 mo	95%
Venturelli A 1996	29 impl.	12 mo	99.9%

Table 9 Safety and effectiveness of implantation in the maxillary tuberosity.

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