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Clin Implant Dent Relat Res 2007; 9:15-21

## Short Implants placed one-stage in maxillae and mandibles: A 2-Year Retrospective Clinical Study

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## ABSTRACT

**Background:** The use of short implants (7-8.5 mm) has historically been associated with lower survival rates than for longer implants. However, recent clinical studies indicate that short implants may support most prosthetic restorations quite adequately, but still clinical documentation is sparse.

**Purpose:** The purpose of this study was to report on the placement of short Brånemark implants, testing the hypothesis that short implants in atrophied jaws might give similar long-term implant survival rates as longer implants used in larger bone volumes.

**Materials and Methods:** This study included 170 consecutively treated patients with 383 short (7-8.5mm) implants (Brånemark System®; NobelSpeedy®; Nobel Biocare AB, Gothenburg; Sweden) supporting 251 fixed prostheses. One hundred twenty-two of the implants were 7 mm long and 261 were 8.5 mm long; being 256 implants with machined surfaces and 127 implants with oxidized surfaces (TiUnite™, Nobel Biocare AB, Gothenburg, Sweden). Final abutments were delivered at time of surgery, and final prostheses were delivered 4-6 months later.

**Results:** One hundred and ten of the 7mm implants (90%) have passed the 1-year, 103 (84%) the 2-years and 43 (35%) the 5-years follow-up. Five implants failed in four patients before the 6-month follow-up, giving a cumulative survival rate of 95.9% at 2 years. The average bone resorption was 1mm (S.D. 0.6mm) after the first year.

Two hundred and twenty six of the 8.5mm implants (86,6%) have passed the 1-year and 207 (79.3%) the 2-years and 68 (26,1%) the 5 years follow-up. Eight implants failed in seven patients before the 6-month follow-up, giving a cumulative survival rate of 96.9% at 2 years. The average bone resorption was 1.3mm (S.D. 0.8mm) after the first year.

**Conclusions:** The cumulative survival rates of 95.9% and 96.9% at 2 years for implants of 7mm and 8.5mm length respectively, indicates that within the limitations of this study, one-stage short Brånemark implants can be used to rehabilitate both jaws.

**Key words:** Brånemark implants, short implants, one-stage protocol, retrospective study, long-term.

## INTRODUCTION

The use of short implants (7- 8.5 mm) has long been associated with low success rates.<sup>1,2</sup> Their use has also been discouraged from a biomechanical point of view, when combined with poor bone quality and high occlusal loads.<sup>3</sup> However, the development of implant design, surface structure and improved surgical technique have given reason to re-evaluate previous results, and recent clinical studies indicate that short implants may support most prosthetic restorations quite adequately. Survival rates around 95% are reported for the rehabilitation of partial edentulism and severely resorbed maxillae,<sup>4,5</sup> and 88% to 100% for the atrophic mandible.<sup>6</sup>

Finite element analysis indicates that the maximum bone stress is practically independent of the implant length.<sup>1</sup> From studies using an experimental canine model it was reported that increasing implant length from 7mm to 10mm did not significantly improve the anchorage.<sup>7</sup> Further, no differences were observed between short implants and other prosthetic rehabilitation modalities of the severely resorbed mandible (namely endosseous implants with augmentation and transmandibular implants).<sup>8</sup>

These recent experiences indicate that today's short implants (7-8.5mm), with modified surfaces and adequate implant insertion techniques, might be equally effective as longer implants. However, clinical documentation is still sparse. The purpose of this study was to test the hypothesis that short implants in prosthetic rehabilitation of atrophied jaws might give similar long-term implant survival rates as longer implants used in larger bone volumes.

## MATERIALS AND METHODS

This retrospective clinical study was performed in a private clinic, Clinica Maló, in Lisbon, Portugal, and included 170 consecutively treated patients (49 males and 121 females) with 383 implants (Brånemark System<sup>®</sup> MkII, MkIII and Mk IV, and NobelSpeedy Shorty; Nobel Biocare AB, Gothenburg; Sweden) supporting 251 prostheses. The same team performed surgery and prosthetic placement. The first patient was treated in July 1996 and the last in October 2004, and the patients were followed between 1 and 9 years. The patients' ages ranged from 27 to 86 years (mean 54).

Two-hundred-and-fifty-six implants had machined surfaces while 127 implants had oxidized surfaces (TiUnite™, Nobel Biocare AB, Gothenburg, Sweden). Of the 7mm implants, 17 had 3.75mm and 105 had 4mm diameters, while for the 8.5mm implants, 67 had 3.75 mm and 194 had 4mm diameters.

One hundred and twenty - six implants were placed in the maxilla (25 by 7mm and 101 by 8.5mm); and 257 in the mandible (97 by 7.0mm and 160 by 8.5mm). Fifty-eight implants supported single teeth rehabilitations (15 by 7.0mm and 43 by 8.5mm); 292 implants small bridges (98 by 7.0mm 194 by 8.5mm); and 33 implants complete edentulous rehabilitations (09 by 7.0mm and 24 by 8.5mm). Of the 292 implants placed in small bridge rehabilitations 187 (69 by 7.0mm and 118 by 8.5mm) were splinted to longer implants.

### **Inclusion/exclusion criteria**

The patients were included in the study provided they were in need of implant-supported restorations; had good general health; and had atrophied jawbone but sufficient height to place at minimum a 7-mm-long implant. Short implants splinted to longer implants at the final prosthetic rehabilitation were accepted, as well as short implants placed in grafted bone.

As exclusion criteria, those generally used when performing implant treatment were followed.<sup>9</sup> Further, patients with the following conditions were excluded: immunodeficiency pathology; bruxism; stress situation (socially or professionally); emotional instability; and unrealistic esthetic demands.

### **Surgical Protocol**

Prophylactic pre-surgery and 15 days post-surgery antibiotics (Oraminax<sup>®</sup>, 1g, Wyeth Laboratories, Azevedos, Algés, Portugal), anti-inflammatory medication (Nimed<sup>®</sup>, Rhône-Poulenc Rorer, Lda, Mem Martins, Portugal), and analgesics (Clonix<sup>®</sup>, Barcarena, Portugal, Janssen-Cilag, Brussels, Belgium) were used. Some patients were sedated (Valium<sup>®</sup>, 10 mg, Roche, Amadora, Portugal) before surgery, which was performed under local anesthesia (Rapicaine<sup>®</sup>, 2% ep, lidocaine HCl 2% with epinephrine 1:100,000, Unipharm, Vera Cruz, Mexico). Post-surgically, a chlorhexidine gel (Elugel<sup>®</sup>, Pierre Fabre Dermo Cosmetique, Lda, Lisboa, Portugal) was placed over the area around the tooth. The patient was instructed to rinse with chlorhexidine solution (Eludril<sup>®</sup>, Pierre Fabre Dermo Cosmetique, Lda, Lisboa, Portugal) daily for 15 days.

The insertion of the implants followed the standard procedures<sup>10</sup> with the following modifications: incision was performed on the palatal side of the crest for maximum tissue repositioning of the papilla, and the flaps were kept as small as possible, to maximize the blood supply to the implant site after surgery.

The drilling sequence was modified in order to achieve maximum apical compression and anchorage. For 3.75-mm implants, sites were initially prepared with 2.0-mm twist drills. The coronal one half of these sites was then enlarged with 2.8-mm twist drills. For 4.0-mm implants, the sites were prepared with 2.8-mm twist drills. The coronal one half of these sites was enlarged with 3.15-mm twist drills. Countersinking was eliminated in order to preserve marginal bone.<sup>11</sup> The minimum insertion torque for accepting the implant was 32 Ncm.

The implant platform was aimed to be 0.8 mm above the bone crest, i.e. the lower corner of the cylindrical part of the implant flange was placed flush to the bone crest. Bicortical anchorage was established whenever possible. The abutment choice was made according to the rehabilitation: For single teeth, CeraOne abutments were used and for small bridges and complete edentulous rehabilitations, Miruscone, Estheticone or Multi-unit abutments were used (Nobel Biocare AB, Gothenburg, Sweden). Final abutments were attached after the implant placement and the soft tissues were readapted and sutured back into position with 4-0 non-resorbable sutures. The abutments were protected with healing caps, but in 16 cases (23 implants) a provisional prosthesis was attached directly after surgery for immediate function.

### **Postoperative Protocol**

The patients were instructed not to chew on the implants for 4 months. Ten days after surgery, the sutures were removed, and hygiene and implant stability were checked, a procedure that was repeated after 2 and 4 months. After 4-6 months, the final crowns or prostheses were placed. A clinical case is presented in Figure 1.

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### **Dropout**

Two patients with 5 implants died due to unrelated causes, 21 months and 2 years after implant placement, consequently, data related to these cases were withdrawn from the study.

### **Implant Survival Criteria**

To be classified as survival, the implants needed to fulfill the following criteria: clinical stability (bridges removed and implants individually checked); fulfilled purported function without any discomfort to the patient; no suppuration or infection present; and no radiolucent areas around the implants.

### **Marginal Bone Evaluation**

Periapical radiographs were taken at implant insertion, at 6 months, 1 year, and 5 years. A conventional radiograph holder was used, and its position was manually adjusted for an estimated orthognatic position of the film. The reference point for the reading was the implant platform (the horizontal interface between the implant and the abutment), and marginal bone remodeling was defined as the difference in marginal bone level relative to the bone level at time of surgery. The radiographs were grouped as follows: implant insertion, 1-year follow-up, and 5 years and longer follow-up.

### **Complications**

The following complication parameters were assessed: fracture or loosening of mechanical and prosthetic components (mechanical complications); soft tissue inflammation, fistula formation, pain or infection (biological complications); and esthetic complaints of the patient or dentist (esthetic complications).

## RESULTS

All implants were successfully inserted into the desired positions, achieving good primary stability. In total, 13 implants of the 383 implants placed failed, giving an overall 2-year survival rate of 96.6%.

### Cumulative Implant Survival analysis

One hundred and ten of the 7mm implants (90%) have passed the 1-year and 103 (84%) the 2-years and 43 (35%) the 5-years follow-up. Five implants failed in four patients before the 6-month follow-up, giving a cumulative survival rate of 95.9% at 2 years (Table 1).

Two hundred and twenty six of the 8.5mm implants (86.6%) have passed the 1-year and 207 (79,3%) the 2-years and 68 (26,1%) the 5 years follow-up. Eight implants failed in seven patients before the 6-month follow-up, giving a cumulative survival rate of 96.9% at 2 years (Table 2).

One-hundred and twenty-six (126) implants were placed in the maxilla (7.0mm=25; 8.5mm=101) with 10 implant losses (7.0mm=3; 8.5mm=7), giving a 92% overall survival rate (7.0mm=88%; 8.5mm=93%); 257 implants were placed in the mandible (7.0mm=97; 8.5mm=160) with 3 implant losses (7.0mm=2; 8.5mm=1), giving a 98.8% overall survival rate (7.0mm=97.9%; 8.5mm=99.2%) (Table 3).

### Failure analysis

All implant losses occurred during the first 6 months of healing, before prosthetic loading, all had machined surfaces and in most cases the bone was rather soft, being in the maxilla. The failed implants were replaced after 3 to 4 months and were successful in all cases. These implants were not included in the study.

Three of the lost 7.0mm implants were part of small bridge therapy in three patients, one in the posterior maxilla and 2 in the posterior mandible. One of the losses in the mandible was an immediate function case. Two 7.0mm implants (placed bilaterally in the posterior region) belonging to one patient with a complete edentulous rehabilitation

in the maxilla were lost, together with the loss of the rest of the implants (longer implants placed anteriorly), in a total of 5 implants. Four of the lost 8.5mm implants in three patients were part of small bridge rehabilitations in the posterior maxilla. Two of these implants in one patient were placed in a peridontally compromised area and two other implants were immediately function cases. Four 8.5mm implants failed in 4 patients with complete edentulous rehabilitations (2 in the anterior maxilla in two patients submitted to bone graft; 1 in the posterior maxilla and 1 in the posterior mandible).

### **Marginal Bone Loss**

Sixty-three (57%) of the 7mm implants had readable radiographs for marginal bone level assessment. The average bone resorption was 1 mm (SD=0.6) after the first year, (Table 4). One-hundred-fifty-two (67%) of the 8.5mm implants had readable radiographs for marginal bone level assessment. The average bone resorption was 1.3 mm (SD=0.8) after the first year, (Table 5).

### **Complications**

Regarding mechanical complications, 7 patients and 9 implants were assessed having a healing cap loosening during the implants healing period. These were due to the patients having chewed on the implants while ingesting food. They were re-instructed not to chew on the implants and the complication was solved. Regarding biological complications, 4 patients and 4 implants presented a soft-tissue inflammation during the implants healing period, due to plaque accumulation. This was solved by removing the healing cap from the abutment, debriding, polishing with a chlorhexidine gel and placing the healing cap again. No esthetic complaints were registered.

## **DISCUSSION**

The 95.9% and 96.9% 2-year survival rates for 7mm and 8.5mm implants respectively, are comparable to results with longer implants and with results from recent clinical studies of short length implants.<sup>4,5</sup> The number of patients treated, 170, is substantial and gives

weight to the result. It supports the hypothesis that short implants (7-8,5mm) in prosthetic rehabilitation of atrophied jaws might give similar long-term implant survival rates as longer implants used in larger bone volumes. This doesn't implicate that longer implants are obsolete. The interpretation is that with sufficient initial implant stability a short implant may be equally effective as a longer one. This is in accordance with theoretical analyses of load transfer between implant and bone.<sup>1</sup> There was also a tendency of lower survival rates in maxillae (92%) compared to the mandible (99%), probably due to softer maxillary bone, i.e. the same tendency as for longer implants.<sup>12,13</sup>

All failures occurred before prosthesis attachment. This could be due to the fact that there was some load on the implant healing caps. As a matter of fact, wear marks were often observed on the plastic healing caps at time of prosthesis attachment. This indicates that implants with questionable prognosis might have failed before the prosthetic procedure. As all failures occurred before prosthesis attachment, the type of restoration became a non-issue relative to implant survival.

The mean marginal bone resorption after 1 year is comparable to other studies on short implants<sup>5</sup> and results for longer implants.<sup>14</sup> However, the marginal bone level changes affects a relatively larger portion in short implants and at the few implants followed for 5 years 25% of the 7mm implants and 33% of the 8.5mm implants presented a bone loss between 2 and 3mm, representing almost half of the 7mm implant and one-fourth of the 8.5mm implants (Tables 4 and 5). Still no late losses occurred in long term. This supports the understanding that the major part of the load transfer to the bone occurs within a few mm length of the implants and that there is no need for long implants per se if osseointegration has taken place. However, more clinical data is needed to further investigate the long-term function of short implants.

## CONCLUSIONS

The cumulative survival rate of 95.9% for 7mm implants and 96.9% for 8.5mm implants after 2 years indicates that short implants used in both jaws represent a treatment alternative for rehabilitation of areas with small bone volume, where it's impossible to place longer implants. Further studies are recommended to investigate the virtues of short implants as their use may facilitate patient treatment in atrophied jaws.

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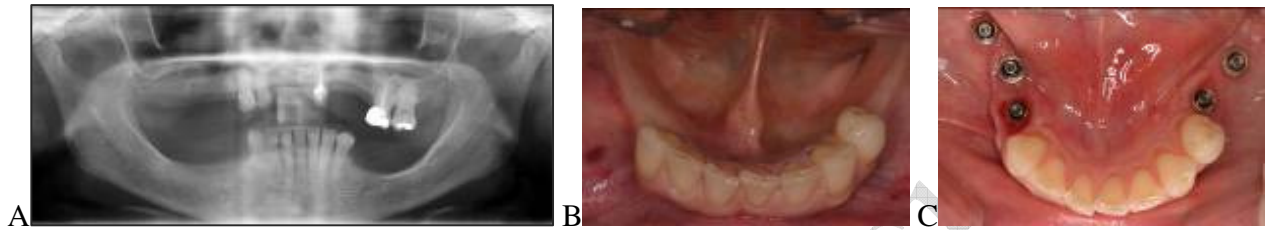
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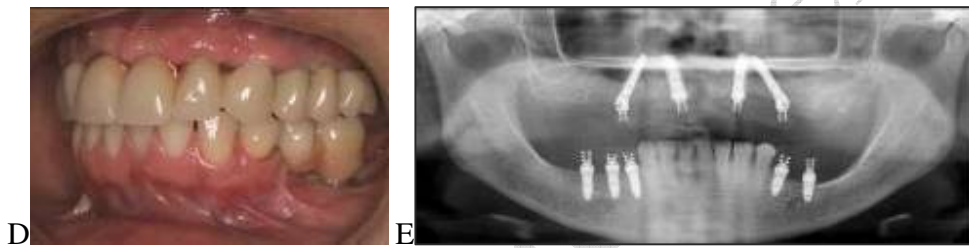
### FIGURE LEGEND

**Figure 1-** A small bridge rehabilitation in the posterior area of the 3<sup>rd</sup> quadrant with 2 implants (4X8.5mm and 4X7mm) in one-stage surgery.

(Prosthesis performed by Dr. Joana Lima)



A-Pre-operative panoramic x-ray; B-Pre-operative intra-oral view; C-Post-operative intra-oral view



D- Lateral view after provisional bridge connection; E- Panoramic x-ray after provisional bridge connection



F- Frontal view after final bridge connection; G- Lateral view after final bridge connection



H- Occlusal view after final bridge connection; I- Panoramic x-ray after final bridge connection

**TABLE INDEX:**

Table 1. Life table analysis regarding implants survival (7mm implants)					
Duration	Total	Number of implants			CSR (%)
		Failed	Withdrawn	Not yet due	
Placement- 6mo	122	5	0	7	95.9
6mo- 1 yr	110	0	0	0	95.9
1- 2 yrs	110	0	0	7	95.9
2- 3 yrs	103	0	0	11	95.9
3- 4 yrs	92	0	0	11	95.9
4- 5 yrs	81	0	0	38	95.9
5- 6 yrs	43	0	0	25	95.9
6- 7 yrs	18	0	0	16	95.9

CSR= Cumulative survival rate.

Table 2. Life table analysis regarding implants survival (8.5mm implants)					
Duration	Total	Number of implants			CSR (%)
		Failed	Withdrawn	Not yet due	
Placement- 6mo	261	8	0	15	96.9
6mo- 1 yr	238	0	0	12	96.9
1- 2 yrs	226	0	3	19	96.9
2- 3 yrs	207	0	0	28	96.9
3- 4 yrs	179	0	0	50	96.9
4- 5 yrs	129	0	0	61	96.9
5- 6 yrs	68	0	0	40	96.9
6- 7 yrs	28	0	0	16	96.9
7- 8 yrs	12	0	0	5	96.9
8- 9 yrs	9	0	0	8	96.9

CSR= Cumulative survival rate.

Table 3: Implant distribution per jaw (Maxilla/Mandible) and per site (anterior/posterior)						
	7.0mm implants			8.5mm implants		
	Total (lost)	Ant. (lost)	Post. (lost)	Total (lost)	Ant. (lost)	Post. (lost)
<b>Maxilla</b>	25(3)	5(2)	20(1)	101(7)	13(2)	88(5)
<b>Mandible</b>	97(2)	0(0)	97(2)	160(1)	0(0)	160(1)
<b>Total</b>	122(5)	5(2)	117(3)	261(8)	13(2)	248(6)

Table 4. Marginal bone resorption 7mm implants									
Bone loss (mm)	Baseline- 1 yr				Baseline- 5 yr				
	Mesial		Distal		Mesial		Distal		
	N	%	N	%	N	%	N	%	
0-1.0	43	68.3	55	87.3	5	31.3	8	50	
1.1-2.0	16	25.4	8	12.7	7	43.8	4	25	
2.1-3.0	4	6.4	0	0	4	25	4	25	
Total implants	63	100	63	100	16	100	16	100	
Mean	1.1	-	0.8	-	1.9	-	1.6	-	
Standard deviation	0.7	-	0.5	-	0.8	-	0.9	-	

Table 5. Marginal bone resorption 8.5mm implants									
Bone loss (mm)	Baseline- 1 yr				Baseline- 5 yr				
	Mesial		Distal		Mesial		Distal		
	N	%	N	%	N	%	N	%	
0-1.0	98	64.5	100	65.8	4	26.7	5	33.3	
1.1-2.0	42	27.6	30	19.7	4	26.7	5	33.3	
2.1-3.0	9	5.9	19	12.5	6	40	4	26.7	
>3.0	3	2	3	2	1	6.7	1	6.7	
Total implants	152	100	152	100	15	100	15	100	
Mean	1.3	-	1.3	-	2.3	-	2.0	-	
Standard deviation	0.8	-	0.8	-	0.9	-	0.9	-	