Simplified Treatment of the Atrophic Posterior Maxilla via Immediate/Early Function and Tilted Implants: A Prospective 1-Year Clinical Study

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ABSTRACT

Background: Posterior maxillae are often difficult to treat owing to the sinus antrum. Placing implants in remaining bone regions in the atrophic maxilla, without performing sinus grafting, is a challenge. Immediate function adds to this challenge.

Purpose: The purpose of this study was to suggest and evaluate a simplified treatment concept for the rehabilitation of the atrophic maxilla using tilted implants subjected to immediate/early function.

Materials and Methods: Eighteen patients were included in the study. Sixty implants were placed to support 19 fixed partial or full-arch prostheses. Immediate/early function was applied. The patients were followed for a minimum of 1 year after prosthesis connection. Stability measurements and radiographic evaluation of the change of the marginal bone level were performed.

Results: One axial and one tilted implant failed in one patient, giving a cumulative survival rate of 96.7%. No failure of provisional prostheses occurred. The mean marginal bone resorption recorded after 1 year was low (0.82 mm for axial implants and 0.34 mm for tilted implants).

Conclusion: The results of the present study suggest that tilted implants placed in immediate function may be a viable treatment approach for the rehabilitation of the atrophied maxilla. Simplified treatment procedures, reduced surgical invasion, shorter treatment time, and reduced costs constitute some of the benefits for the patient and the clinician.

KEY WORDS: angulated abutments, atrophic maxilla, dental implants, flapless, immediate function, immediate loading, implant stability, insertion torque, maxillary sinus, prospective study, resonance frequency analysis, tilted implants

The rehabilitation of the posterior maxilla represents a challenge for clinicians because compromised bone is often present in this jaw region, especially in elderly patients, in whom the sinus antrum tends to enlarge over time. The often insufficient residual bone volume makes implant placement posterior to the first premolar difficult.

The first and second molars are the most commonly missing teeth,[1] most frequently lost owing to periodontal and caries disease.[2–5] Although not indispensable,[6] molars are important for masticatory reasons and may be successfully replaced with fixed prostheses supported by osseointegrated implants.[7]

Many therapeutic options for the rehabilitation of the posterior maxilla have been suggested. Distal cantilevers are a known stratagem for the positioning of teeth in the absence of a fixed support. However, survival rates for implant-supported prostheses with long distal extensions are generally lower than for prostheses with short cantilevers[8]; complications include screw loosening, mechanical fracture of implant or prosthetic components, and bone loss around the distal implant. The placement of short implants is one alternative treatment option but is inadvisable in sites with poor bone quality.[9,10] Bone compacting by the use of an osteotome instrument is another treatment approach[11] but has limitations in the possible amount of bone volume to be gained. Sinus lift grafting is yet another procedure that is well supported in the literature,[12] but patient acceptance is relatively low owing to the risk of morbidity, the graft choice dilemma, and costs. Furthermore, grafting may result in complications, such as infection and consequent bone loss.

The placement of implants into the tuberosity and the area of the pterygoid process has been used to over-

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come the sinus antrum obstacle.[13] However, this treatment modality is associated with a risk of vascular damage owing to the presence of the descending maxillary artery and its branching arteries close to the region of the pterygopalatine fossa.[14] Zygoma implants seem to be a valuable addition to the therapeutic repertoire for the management of the compromised maxilla[15]; however, because this type of implant relies on anchorage in the dense midfacial zygomatic bone, considerable experience is required to place them.

Lately, several authors have documented the clinical efficacy of tilting distal implants, placing them parallel to the anterior sinus wall and positioning the implant platform in a more posterior position.[16–20] The tilted implants can be anchored in the bone pyramid anterior to the maxillary sinus, where no anatomic vital structures, such as arteries or nerves, are present. Multiunit implantation following this approach makes it possible to extend the prosthetic support posteriorly, thus reducing cantilever arms. The results from biomechanical analyses[17] and an animal study[21] indicate that tilting of implants has no adverse effect on bone resorption.

The advantages of the immediate/early function concept are well known. The possibility of immediately installing fixed prostheses is the most obvious advantage, but the protocol is also less time-consuming for both the patient and the dentist. Numerous scientific investigations support the concept of immediate/early function as a modern therapeutic option,[22–30] and experiences from immediate function in the maxilla have been reported by several authors.[31–38]

Stimulated by the encouraging outcomes of previous studies on immediate/early function and studies on the use of tilted maxillary implants, we decided to evaluate the combination of both concepts as an alternative treatment of the atrophic posterior maxilla. The purpose of this study was to develop a clinical protocol for the use of tilted posterior implants placed in immediate/early function and to evaluate its clinical efficacy.

MATERIALS AND METHODS

This prospective study was performed in accordance with the Declaration of Helsinki. The study included 18 patients with a mean age of 64 years (range 51–76 years) (Table 1) treated between January 2001 and December 2003. The patients were followed for a minimum of 1 year (range 1–4 years).

TABLE 1 Patient Age and Gender

Age,* yr	Male	Female	Total
50–60	2	3	5
60–70	1	6	7
70–80	4	2	6
Total	7	11	18

*Mean age 64 years, range 51–76 years.

Sixty implants were placed: 39 Brånemark System® Mk IV implants (Nobel Biocare AB, Göteborg, Sweden) and 21 Replace® Select Tapered implants (Nobel Biocare AB). The implants were used for the treatment of partial and total edentulism in the posterior region of the maxilla (Table 2). Eleven of the Brånemark implants had a machined surface (six installed in one patient) and 28 had an oxidized surface (TiUnite™, Nobel Biocare AB). One patient received 3 Replace implants with acid-etched titanium surfaces; the remaining 18 Replace implants had an oxidized surface (TiUnite). The length of the implants ranged from 10 to 15 mm.

Inclusion/Exclusion Criteria

Patients expressing strong reservations for sinus grafting were informed of the possibility of receiving the alternative treatment involving tilted implants. The

TABLE 2 Number of Prostheses According to Type of Restoration

Prosthesis	Number of Patients	Implants per Type of Prosthesis	Number of Prostheses
Partial restoration*	11		12
Full-arch restoration†	1		1
	1		1
	2		2
	3		3
Total	18		19

*Average 2.2 implants per restoration.
†Average 5 implants per restoration.

patients were also informed of the possibility of immediately loading these implants. To be included in the study, the patients had to sign a written consent form. Further inclusion criteria were good general health, the possibility of placing at least 10 mm–long implants, and the possibility of benefit from the splinting effect of two or more implants. Patients with a positive medical history, bruxers, and heavy smokers were excluded from the study.

Treatment Planning

The implants were placed in combination with at least one more implant in cases of partial edentulism and in combination with at least two more implants with cross-arch stabilization in cases of total edentulism. Thirty-three implants (19 Brånemark, 14 Replace) were placed axially and 27 implants (20 Brånemark and 7 Replace) were tilted. The implants supported 12 partial and 7 full-arch restorations (see Table 2).

The axial implants were placed in the anterior and first premolar sites, whereas the tilted implants were placed in the second premolar and first molar positions. The implants were tilted 17° to 45° relative to the vertical plane (Table 3). Twenty-three of 27 tilted implants were angulated more than 30° posteriorly to bypass the sinus; the remaining four implants were tilted less than 30°. Four anterior implants were tilted to avoid the nasal fossa. Periodontally involved teeth were treated before implant placement.

The opposing dentition of 18 patients was natural teeth or implant-supported prostheses, whereas 2 patients had removable dentures. The implants were placed in healed sites, except for nine axial implants (Replace Select Tapered, TiUnite), which were inserted in noninfected postextractive sockets.

Surgical Protocol

Local anesthesia, articaine with 2% adrenaline (Ultracain®, ESPE, Seefeld, Germany), was administered. Antibiotic prophylaxis (Zimox®, 1 g, Pharmacia & Upjohn, Milan, Italy) was administered 1 hour before surgery and for the following 3 days. The patients were given antiinflammatory and analgesic medication (Synflex® Forte, 550 mg, Recordati, Milan, Italy). A sedative premedication (diazepam [Valium®], Roche, Milan, Italy) was administered to anxious patients. Chlorhexidine digluconate 0.12% (Corsodyl®, SmithKline Beecham, Milan, Italy) mouthrinse and ice applications were given postoperatively.

Flapless surgery was performed in five patients, for whom the computed tomographic scan examination demonstrated abundant bone volume and keratinized mucosa (Figure 1). In the other patients, a midcrestal scalloped incision was performed. After elevation of the flap, bone ridge evaluation was performed and bone quality and quantity were recorded. Countersinking was avoided in order for the implant to engage as much of the crestal bone as possible. The sites were generally

TABLE 3 Degrees of Angulations of the Tilted Implants

	Number of Implants per Angulation	
Inclination	15–30°	> 30°
Mesiodistal	0	23
Distomesial	4	0

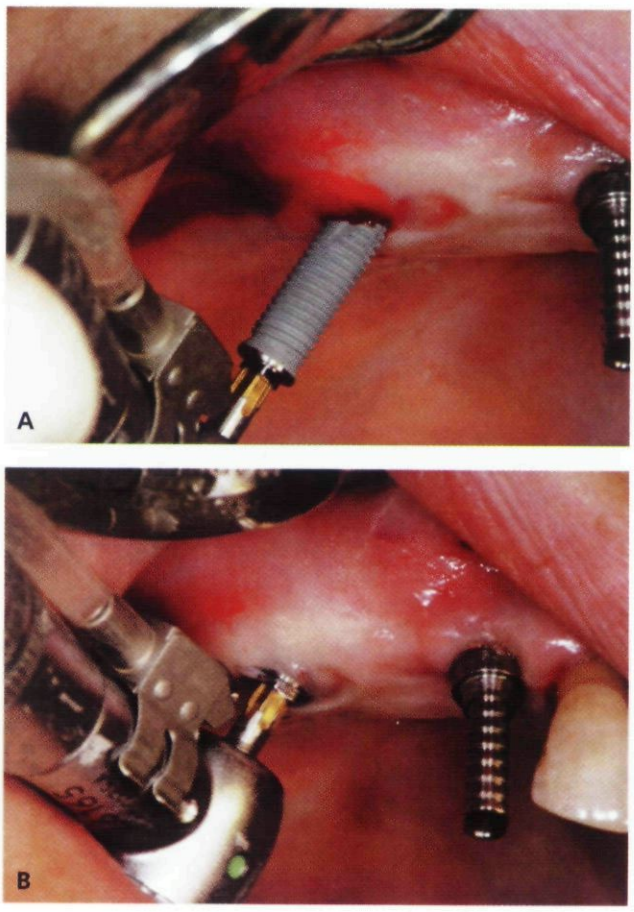


Figure 1 Wide bone recipient and abundant keratinized mucosa are mandatory for flapless insertion. *A*, Angulations of the insertion; *B*, Diminution of bleeding during insertion with soft tissue seal.

slightly underprepared in full length to ensure high implant stability. A torque controller (Osseocare™, Nobel Biocare AB) with a torque limit of 50 Ncm was used for implant insertion. A manual torque wrench was used in cases of incomplete seating of the implant.

The mesial implants (axial) were placed before the tilted implants (Figure 2). An intraoperative periapical radiograph (see Figure 2A) was taken after placement of the axial implant and served as a reference for the preparation of the tilted implant site. The distance between the axial implant (distal neck) and the center of the planned tilted implant site were measured with a periodontal probe (see Figure 2B). The angulation of the tilted implant was verified against the anterior sinus wall and the axial implant, as seen on a radiograph. Normal angulations ranged between 25° and 55° relative to the axial implant, or 45° to 75° relative to the occlusal plane, depending on the individual anatomy (Figure 3). After the first 5 mm of preparation, an intrasurgical radiograph was taken (see Figure 2C) to verify the drill direction; at this point, the direction of the drill could then be corrected if needed. Thereafter, the full-site preparation was completed. Using this approach, there was no need to pierce or to partially open the sinus; this methodology also made it possible to install the implants flapless in sites with abundant bone (see Figure 1). No precautions were taken to avoid implant apex conflict in cases with a restricted bone area.

Bone density was assessed based on intrasurgical drilling cutting resistance according to Lekholm and Zarb.[39] Bone quality and quantity belonged to classes 2, 3, and 4 (quality) and A, B, and C (quantity) (Table 4). Primary stability in terms of implant insertion torque (Osseocare) was assessed at implant insertion (Table 5).

Prosthetic Protocol

Definitive angulated (17° or 30°) abutments (Nobel Biocare AB) were attached to the tilted implants to straighten the prosthetic axis (Figure 4). The flaps were then adapted and sutured around the abutment. A screw-retained temporary prosthesis was delivered on the day of surgery or after a few days.

Immediate loading was applied for partial restorations. In these cases, a titanium temporary cylinder (Nobel Biocare AB) was screwed onto the definitive abutment. The method has been described in a previous study.[40] The dental laboratory prepared preoperatively a thermoforming stent coated with composite at the inner surface (Protemp III, ESPE), forming a composite prosthesis based on the wax-up (Figure 5A). Holes in the stent in the direction of the long axis of the implants were created to fit the temporary cylinders

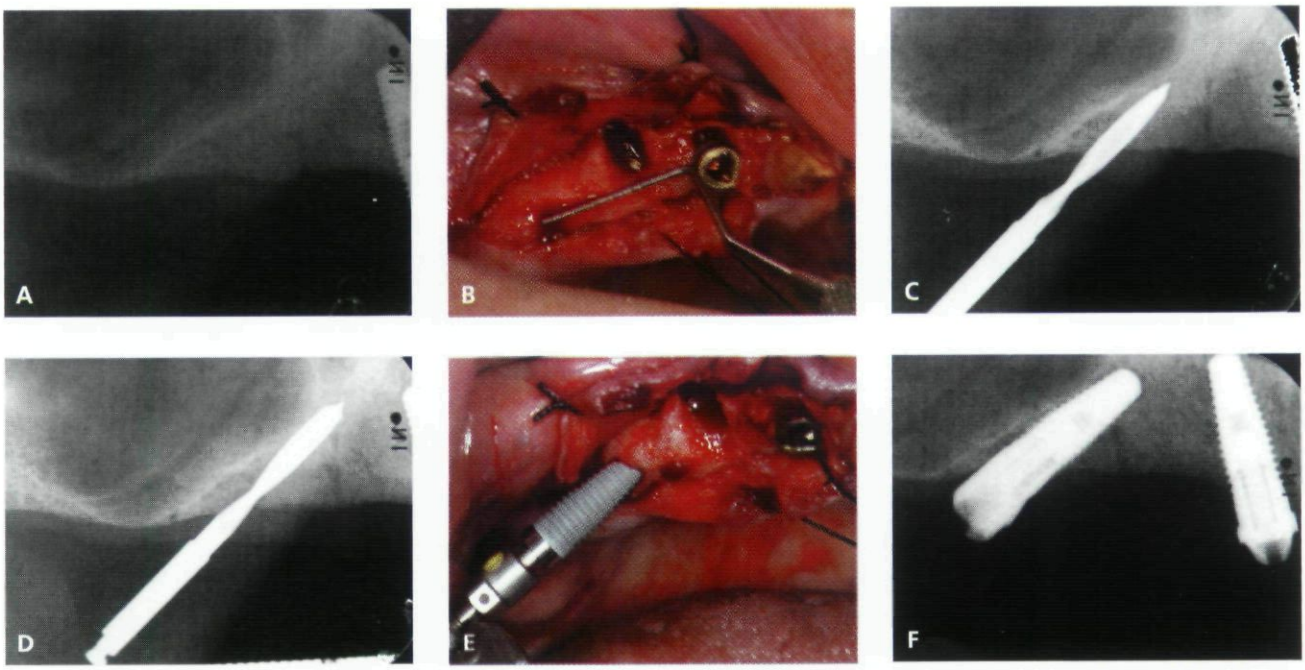


Figure 2 The surgical protocol included placing mesial axial implants before tilted ones. *A*, The distance from the mesial implant to the tilted implant site is measured on the radiograph. *B*, Verification of the distance is performed with the periodontal probe. *C* and *D*, Drilling of the titled implant site. One to two intrasurgical radiographs are necessary to assess the precise drilling direction. *E*, Implant insertion following the direction of the initial hole. *F*, Final radiograph. In the presented case, a flap was raised.

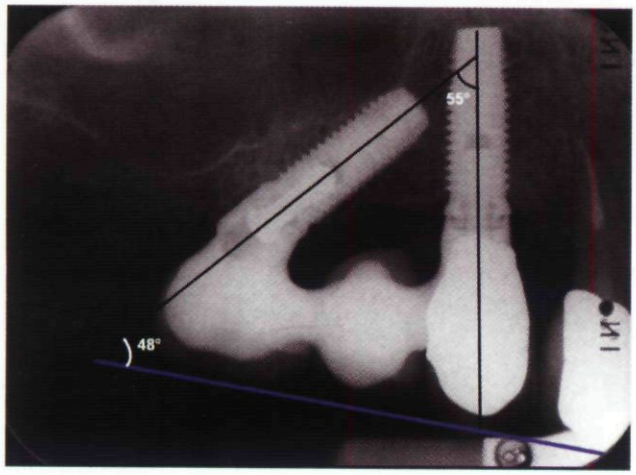


Figure 3 When a triangular bone area is available, the present protocol can be applied. This radiograph shows a case after 2 years. The distal implant was tilted 55° with respect to the mesial implant and 48° relative to the occlusal plane.

(Figure 5B). After fastening the cylinders to the stent by composite flow, the prosthesis was unscrewed, removed from the mouth (Figure 5C), relined (Figure 5D), and screwed back in position. The aim of this original technique was to obtain restoration-driven implant placement using a high-performance temporary composite bridge. Initially, temporary acrylic bridges were used, but some fractures occurred, and the method was modified and improved as described.[40] Great care was taken to obtain a precise fit and to apply a final torque, allowing for good screw retention.

Early implant loading was applied for full-arch restorations. In these cases, fixture impressions were taken according to the traditional pick-up technique with open tray, polyether material (Permadyne, ESPE) and splinted transfer by composite flow (Tetric Flow, Ivoclar Vivodent AG, Schaan, Liechtenstein). Healing caps (Nobel Biocare AB) were screwed onto the final abutments and were also used for the interjaw relationship record. The material was delivered to the laboratory, and on the same evening or the following day, the provisional composite bridge was screwed in place.

TABLE 4 Bone Quality and Quantity Distribution*

	Quantity			
Quality	A	B	C	Total Quantity
2	7	6	5	18
3	6	9	2	17
4	12	5	—	17
Total quality	25	20	7	52

*Classification according to Lekholm and Zarb.[39] Of the 60 implants in the study, data were not obtained for 8 implants (13.3%).

TABLE 5 Insertion Torque of Axial and Tilted Implants of Survival Implants

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

The difference between axial and tilted implants was nonsignificant.

The provisional prostheses were placed in full centric occlusion, and a simplified occlusal design[41] was chosen as an occlusal guideline. The occlusion was verified by means of an indicator paper and shim stock strips. Patients were asked to exercise normal masticatory function, meaning that restrictions were made to avoid very hard food. Four to 6 months postsurgery, final prostheses were delivered: Procera® abutments ($n = 3$) for cemented retentions and Procera® Implant Bridge($n = 16$) (Nobel Biocare AB) for screw-retained reconstructions.

Follow-Up and Study Parameters

Follow-up examinations were performed monthly during the first 6 months and annually thereafter.

Resonance frequency analysis (Osstell®, Integration Diagnostics AB, Göteborg, Sweden) was performed as an indicator of primary and secondary implant stability and was recorded at baseline and every month thereafter for 6 months. Possible correlations between insertion torque values (obtained at placement) and resonance frequency measurements (obtained at placement, at 3 months, and at 6 months) were investigated.

Radiographs were taken at baseline; after 3 months, 6 months, and 1 year; and once a year thereafter. The radiographs were taken perpendicularly to the long axis of the implants using conventional film holders or manual forceps. In cases of nonreadable radiographs, the radiographic examination was repeated.

The change in the marginal bone level was evaluated based on radiographic readings performed by an independent radiologist. The radiographs were digitized (Epson 1240, 800 dpi) by scanning. An image analysis program (NIH Image Version 4.0.2, Scion Corp., Frederick, MD, USA) was used to measure the distance between the implant platform and the most coronal level of the bone in contact with the implant surface. The diameter of the implant head being

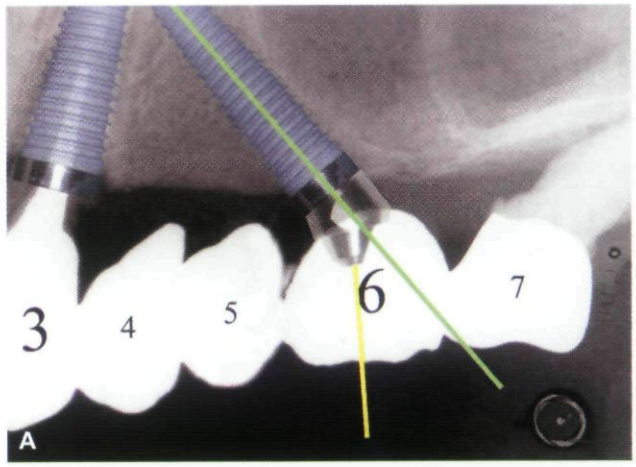
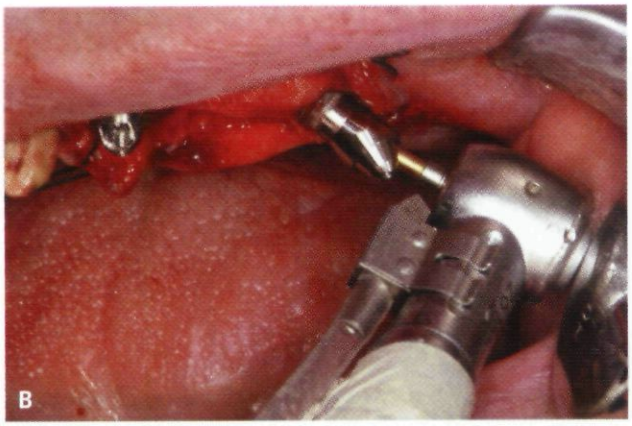
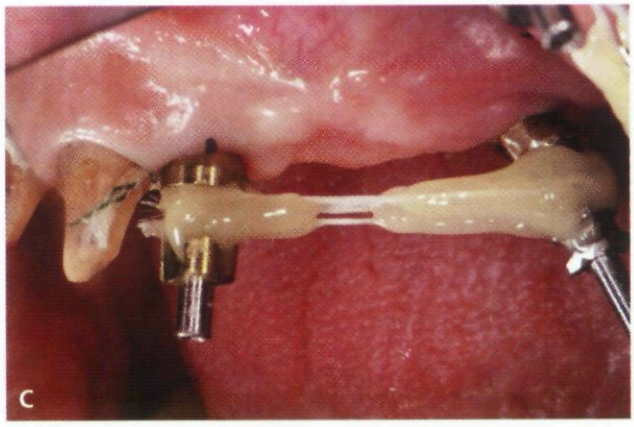
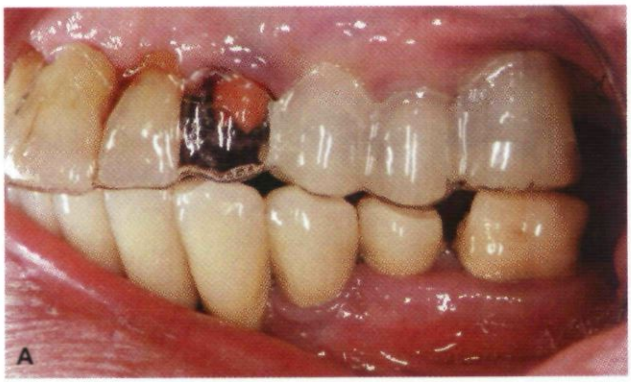
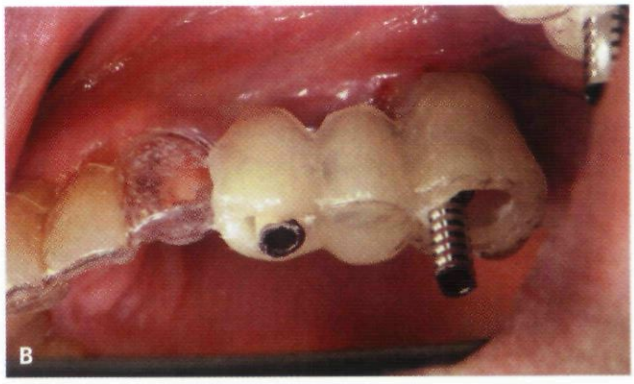


Figure 4 Angulated abutments (17–30°) placed during surgery are mandatory if immediate function is planned. *A*, Virtual planing shows the discrepancies between implant axle and prosthetic axle. *B*, Procedure recommended to definitely screw the abutments with the torque controller. *C*, Impressions are taken on top of the abutments to avoid divergence conflict.









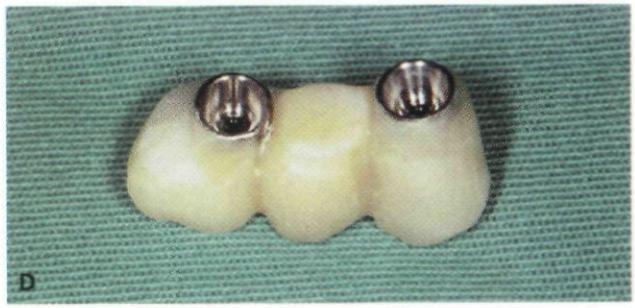


Figure 5 Prosthetic protocol for the immediate method. *A*, Thermoforming stent coated with composite at the inner surface. *B*, Holes in the direction of the long axis of the implant were created in the stent to fit the temporary cylinders. *C*, After fastening the cylinders to the stent by means of composite flow, the prosthesis was unscrewed and removed from the mouth and (*D*) relined.

known, it was used as a reference for the calibration of the radiographs to an accuracy of 0.01 mm. The bone level at implant placement was defined as baseline for the evaluation of the marginal bone resorption. The marginal bone change was calculated as the difference between the reading at the follow-up examinations and the baseline value. Mesial and distal bone height measurements were averaged for each implant.

Because tilting of implants leads to different marginal bone situations on the mesial and distal aspects of the implant, a statistical analysis was performed to assess possible differences in bone resorption on the mesial and distal sides. The 1-year radiographic data were used as a reference for the statistical analysis.

Survival Criteria

Implant survival was based on quantitative measurements of the individual implant as suggested by Roos and colleagues.[42] An implant was classified as surviving if it fulfilled its purported function, if no persistent pain or discomfort was reported, and if no implant mobility was observed.

Prosthetic survival was defined as a prosthesis fulfilling its purported function or, in the case of implant loss, as a reduction in the function of the provisional prosthesis owing to implant failure but without complete prosthesis removal. In the latter case, the failed implant was replaced and the definitive prosthesis was applied as planned. Prosthetic failure was defined as the situation in which the number of implants lost was large enough to require the removal of the entire prosthesis, therefore leading to the lack of function of the prosthesis.

Statistical Analysis

Descriptive statistics for continuous variables were summarized as the mean value ± standard deviation. *t*-Tests or nonparametric analyses by median value tests were applied for the evaluation of differences between dependent or independent samples; a p value less than .05 was considered statistically significant. Cumulative survival rates were calculated using life table analyses. The Spearman coefficient correlation test was used to correlate the insertion torque at placement to the resonance frequency values obtained at placement and after 3 and 6 months. All analyses were performed using computerized statistical software (SPSS, version 11.0, SPSS Inc., Chicago, IL, USA).

RESULTS

One patient treated in January 2004 with a full-arch bridge and two axial and two tilted oxidized implants died in August 2004 for reasons not related to the dental therapy and was withdrawn from the study. All other patients attended all scheduled follow-up visits. During the observation period, 2 implant failures were recorded in one patient (1 axial and 1 tilted implant with machined surfaces), giving cumulative survival rates of 97.0% and 96.3% for the axial (33 implants, 1 failure) and tilted (27 implants, 1 failure) implants, respectively. The overall cumulative implant survival rate was 96.7% (Table 6).

TABLE 6 Implant Follow-Up and Survival Rates for Tilted and Axial Implants

	Number of Implants			Survival Rate	
Time	At Beginning of Period	Withdrawn	Failed	During Period, %	Cumulative, %
Axial					
Baseline	33			100	100
0–6 mo	32	0	1	97.0	97.0
6–12 mo	32	0	0	100	97.0
1–2 yr	25	0	0	100	97.0
2–3 yr	14	0	0	100	97.0
> 3 yr	5	0	0	100	97.0
Tilted					
Baseline	27			100	100
0–6 mo	26	0	1	96.3	96.3
6–12 mo	22	4	0	100	96.3
1–2 yr	16	0	0	100	96.3
2–3 yr	9	0	0	100	96.3
> 3 yr	2	0	0	100	96.3

Implant Failures

The two implant failures occurred after 4 months in a patient with six implants (Brånemark, machined) supporting a complete-arch bridge; one axial implant in position upper left three (UL3) and one tilted implant in position upper left six (UL6) were lost. The implant losses were probably the result of crack propagation and subsequent fracture of the acrylic bridge, leading to micromotion between the implant and the surrounding bone. The failed implants were immediately replaced with implants of a larger diameter and length with an oxidized surface. Sufficient primary stability, permitting immediate function, was reached only for the implant in position UL3. As a result, the provisional prosthesis had to be shortened posteriorly to allow for transmucosal load-free healing of the implant in position UL6. After 3 months of uneventful healing, the implant in position UL6 was integrated in the prosthesis. All other implants remained stable over the time frame of the study.

Prosthetic Complications

Despite implant failure occurring in one full-arch prosthesis, all restorations survived, resulting in a 100% overall survival rate for the provisional prostheses. No screw loosening was recorded, and no prosthetic complications other than the crack propagation and subsequent fracture of the acrylic bridge, as reported above, were observed.

No complications related to implant apex conflict were observed; in situations of narrow bone areas, a favorable adaptation was achieved with the tapered Replace implants owing to their narrow apex (Figure 6).

Clinical Cases

Three clinical cases are shown as illustrations of the final results: two partially edentulous cases (see Figures 6 and 7) and one completely edentulous case (Figure 8).

Radiographic Analysis

Readable radiographs were obtained for all patients. Changes in marginal bone level of 0.63 ± 0.52 mm and 0.82 ± 0.86 mm were recorded for the axial implants after 6 months and 1 year, respectively (Table 7). For the tilted implants, the marginal bone resorption was 0.54 ± 0.74 mm at 6 months and 0.34 ± 0.76 mm at 1 year. The differences in marginal bone resorption between the tilted and the axial implant group were statistically significant. There were no significant differences among other groups (mesial versus distal positions on tilted implants, Brånemark versus Replace implants, and axial versus tilted implants).

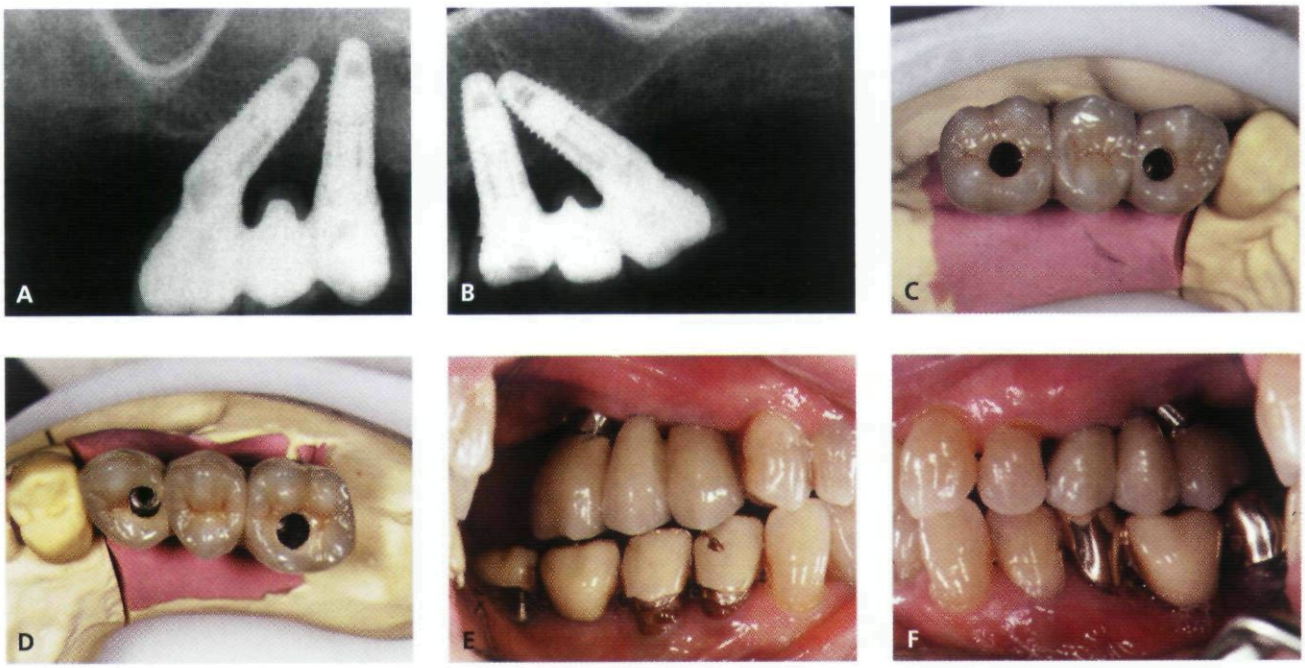


Figure 6 *A* and *B*, Intraoral radiographs from the 1-year follow-up showing Replace Select Tapered implants in a female patient. Thanks to the narrow apex of the tapered implants, good apical adaptation could be achieved in restricted bone areas. *C* and *D*, The definitive restoration consisted of ceramic fused to the Procera Implant Bridge. *E* and *F*, A tilted implant supported the first molars without a prosthetic cantilever.

Implant Stability Analysis

Resonance frequency measurements were performed on all implants. The tilted implants demonstrated high initial stability, which was maintained over time. The implant stability quotient (ISQ) mean values were 59 at baseline, 58 after 3 months, and 60 at 6 months. A similar pattern was observed for the axial implants (57, 58, and 59 ISQ at 0, 3, and 6 months, respectively). No statistical differences in primary stability were found between tilted and axial implants (see Table 5). A correlation was found between the insertion torque obtained at placement and the resonance frequency values recorded at placement ($p < .001$) and after 3 months ($p < .005$). No correlation was found between the insertion torque values and the 6-month resonance frequency recordings.

DISCUSSION

The purpose of this study was to define a protocol for and to evaluate the use of tilted implants in the posterior regions of the atrophied maxilla in combination with immediate/early loading. The implant and prosthesis survival rates (96.7% and 100%, respectively) compared favorably with previously reported results obtained for tilted implants[16–20] and were in line with publications evaluating immediate/early function in the upper jaw.[31–38]

By tilting the posterior implants, the compromised bone of the sinus antrum could be circumvented. Additional clinical advantages of this approach were the possibility of avoiding cantilever arms, creating large interimplant distances, and using fewer implants as

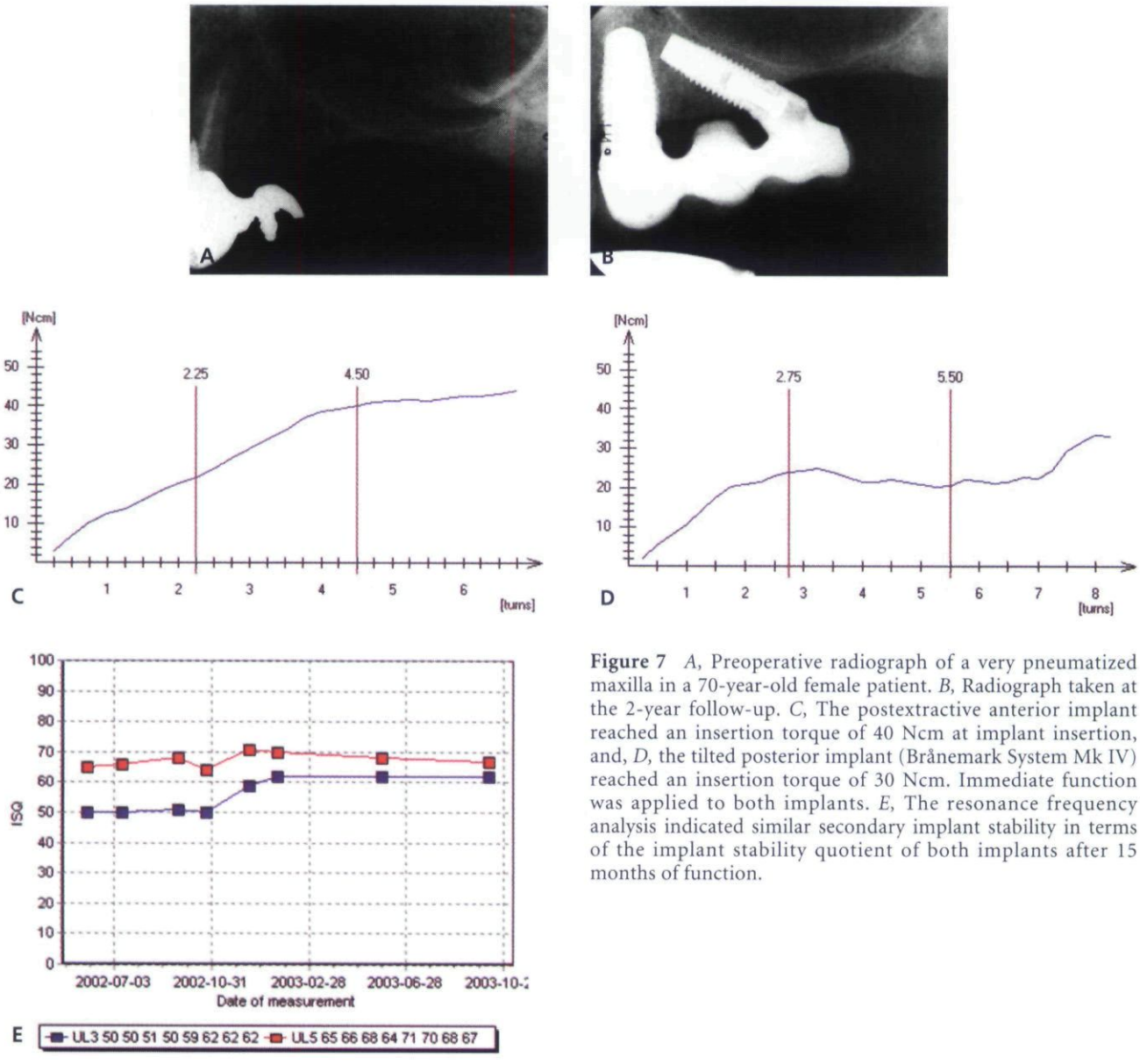


Figure 7 *A*, Preoperative radiograph of a very pneumatized maxilla in a 70-year-old female patient. *B*, Radiograph taken at the 2-year follow-up. *C*, The postextractive anterior implant reached an insertion torque of 40 Ncm at implant insertion, and, *D*, the tilted posterior implant (Brånemark System Mk IV) reached an insertion torque of 30 Ncm. Immediate function was applied to both implants. *E*, The resonance frequency analysis indicated similar secondary implant stability in terms of the implant stability quotient of both implants after 15 months of function.

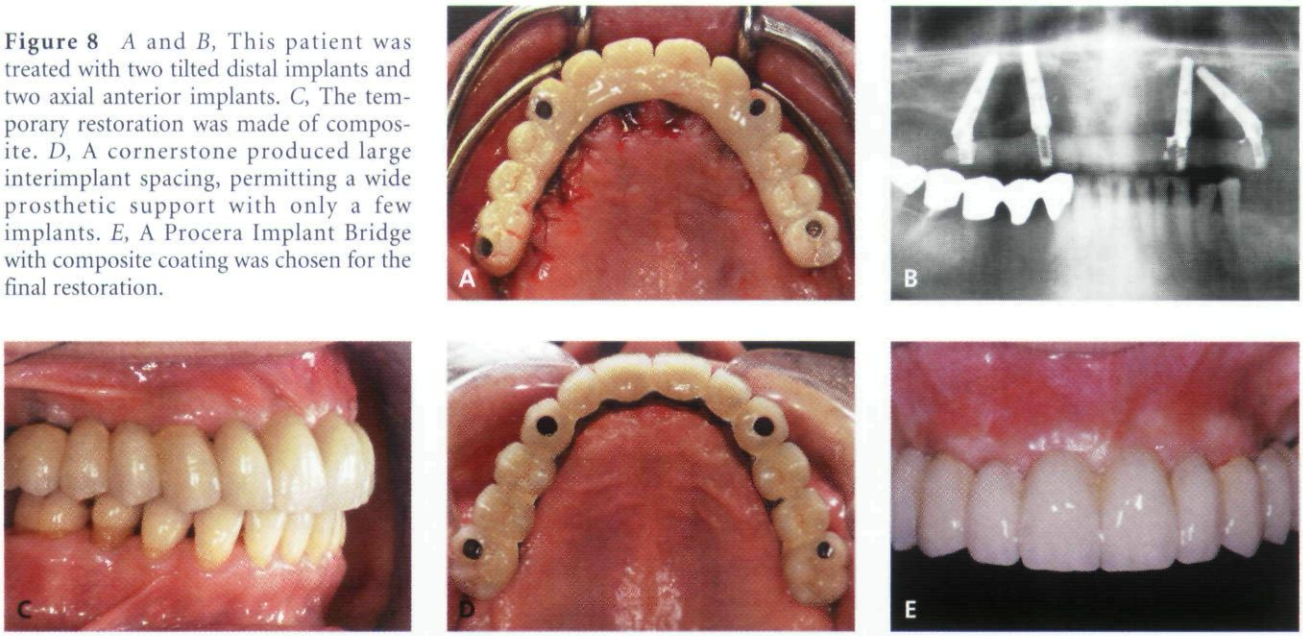


Figure 8 *A* and *B*, This patient was treated with two tilted distal implants and two axial anterior implants. *C*, The temporary restoration was made of composite. *D*, A cornerstone produced large interimplant spacing, permitting a wide prosthetic support with only a few implants. *E*, A Procera Implant Bridge with composite coating was chosen for the final restoration.

support for the prosthetic reconstruction. A standardized protocol was developed and served well.

Two implant failures were recorded. One failure occurred in a situation in which the initial implant stability was low, which underscores the importance of achieving high initial stability for a successful outcome when immediate/early function is applied. The second implant failure was due to fracture of the provisional prosthesis (the fractured prosthesis survived after some revision). The use of acrylic provisional prostheses without metal reinforcement can be critical,[29,40] and when used in combination with immediate/early function, special care should be taken.

The marginal bone resorption was low, 0.82 mm for the axial implants and 0.34 mm for the tilted implants after 1 year, and compared favorably with what has been presented in the literature.[16–20] The lower bone resorption observed for the tilted implants may be related to the position of the implant neck relative to the bone crest; mesially, the neck was positioned supracrestally, whereas distally, it had a subcrestal position, resulting in a favorable soft tissue seal.[43,44] The finding is in accordance with biomechanical analyses[17] predicting "normal" bone stress conditions for tilted implants when splinted. The result is also in agreement with that of animal experiments indicating that bone reactions around implants are not negatively influenced by lateral loading.[21]

Similar implant stability was recorded at baseline and after 6 months, which confirms the viability of immediate/early function; if osseoconductive implants are used, high implant stability may be maintained and masticatory forces may be sustained during the healing process.

Further clinical studies are needed to evaluate the long–term efficacy of this protocol.

CONCLUSION

Within the limitations of this short-term study, encouraging results in favor of the use of tilted implants

TABLE 7 Marginal Bone Change Measured in mm

	Mesial			Distal			Mesial + Distal		
Implant*	3 mo	6 mo	1 yr	3 mo	6 mo	1 yr	3 mo	6 mo	1 yr
Axial ($n = 32$)	0.49	0.61	0.83	0.55	0.65	0.81	0.52	0.63	0.82
	± 0.64	± 0.66	± 1.00	± 0.66	± 0.56	± 0.89	± 0.57	± 0.52	± 0.86
Tilted (n = 26)	0.40	0.43	0.28	0.39	0.64	0.40	0.39	0.54	0.34
	± 0.62	± 0.80	± 0.85	± 0.65	± 0.96	± 0.90	± 0.53	± 0.74	± 0.76

*Of the 60 implants, data were not obtained for 2 failed implants.

together with immediate/early function in the atrophic posterior maxilla were obtained, supporting the viability of this treatment option. The study indicates that a biomechanically advantagous prosthetic support may be obtained by tilting the posterior implants and that implant tilting per se has no negative effect on bone resorption. The findings also support the commonly stated prerequisites for immediate/early function, namely, high initial implant stability, controlled loads, and an osseoconductive implant surface.

ACKNOWLEDGMENTS

We wish to thank Dr. Ciffolilli for the technical support provided for the radiograph analyses and Dr. Sottili for statistical analysis.

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