Immediate Fixed Rehabilitation of the Edentulous Maxilla: A Prospective Clinical and Radiological Study after 3 Years of Loading

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ABSTRACT

Purpose: The aim of this study was to prospectively evaluate the clinical and radiographic outcomes of immediate full-arch fixed maxillary prosthesis supported by two axial and four tilted implants after 3 years of loading.

Materials and Methods: Thirty-two patients with atrophic maxilla were consecutively enrolled and treated. Each patient received a fixed full-arch maxillary rehabilitation supported by four tilted implants that engaged the posterior and the anterior sinus walls and two axial anterior implants. A total of 192 implants (30 Brånemark System MK IV and 162 NobelSpeedy Groovy, Nobel Biocare AB, Göteborg, Sweden) were inserted and immediately loaded. The definitive restorations were placed 6 months later, and follow-up visits were scheduled every 6 months. During follow-ups, marginal bone loss (MBL), plaque and bleeding scores, and patient's satisfaction were recorded.

Results: All patients reached at least 3-year follow-up examination (range 36–78, average 55.53 months). Two tilted implants failed before delivering the definitive restoration, resulting in a cumulative survival rate of 98.96%. All final prostheses were stable and functional, resulting in a cumulative survival and success rate of 100%. At the 3-year follow-up there was no significant difference in MBL between axial (1.55 ± 0.31 mm) and tilted implants (1.46 ± 0.19 mm) ($p = .05$). Plaque and bleeding scores decreased over time, while patient's satisfaction in both aesthetics and function increased.

Conclusions: Implants placement with this configuration could be considered a predictable and cost- and time-effective alternative approach for the immediate restoration of the edentulous maxilla, avoiding bone grafting procedures, even with a medium-term follow-up.

KEY WORDS: dental implants, edentulous maxilla, immediate loading, tilted implant

INTRODUCTION

As suggested by surveys of the scientific literature, immediate loading procedures for edentulous jaws have gained wide popularity among clinicians[1,2] as well as great acceptance by patients. The earliest studies with immediately loaded fixed restorations mainly regarded the lower jaw and they were characterized by the placement of a high number of implants,[3,4] while today a predictable success rate in both arches can be achieved even with as low as four implants independent of the loading timing, and implant primary stability seems to play a determinant role.[2,5–7] The reliability of immediately loaded dental implants in the lower jaw has prompted many clinicians to investigate their application in the upper jaw. Despite that the current literature is growing, the long-term predictability of immediate implant placed in the atrophic maxilla is still pending,[8] due to the prevalence of soft bone and the reduced bone volume, particularly in the posterior region. In order to overcome such limitations, independently of the type of loading protocol, multiple implant-supported

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restorations (up to 14) have been historically used.[9–12] Excluding bone grafting procedures and limiting to patient residual bone, alternative treatments for the atrophic maxilla by means of short implants[13–16] or implants placed in specific anatomical areas like the pterygoid region,[17] the tuber,[18] or the zygoma,[19,20] have been investigated. In the last years, several clinical studies assessed tilted implants as another feasible treatment option, bringing to surgical and prosthetic advantages, and good outcomes.[21–25] The rehabilitation of the edentulous jaws with only four implants (two axial and two tilted), supporting a distal cantilever, was analyzed in recent studies,[26,27] reporting no difference among axial and tilted fashion, in terms of implant survival rate and marginal bone loss (MBL).

The aim of this report was to present a 3-year clinical and radiographic outcomes of a prospective study concerning the immediate rehabilitation of the fully edentulous maxilla with two anterior axial and four posterior tilted implants.[28]

MATERIALS AND METHODS

This study was designed as a prospective cohort study and it was written according to the Strengthening the Reporting of Observational Studies in Epidemiology guidelines.[29] This study evaluates clinical and radiographic outcomes of immediate loaded full-arch fixed maxillary prosthesis supported by two axial and four tilted implants after 3 years of function. Patients were recruited and treated in one rehabilitation center between April 2005 and April 2008, and all subjects were followed for at least 3 years of function. The investigation was conducted according to the principles embodied in the Helsinki Declaration of 1964 for biomedical research involving human subjects, as amended in 2008. Patients were informed of the nature of the study, benefits, risks, and possible alternative treatments. After signature of the informed consent form, patients were consecutively enrolled. A total of 192 implants (Nobel Biocare AB, Göteborg, Sweden) were inserted and immediately loaded, supporting 32 fixed full-arch maxillary rehabilitations.

One expert clinician performed all surgical and prosthetic procedures. Any patient of both sexes, aged 18 years or older, with severe atrophy of the posterior maxilla, requiring a fixed implant-supported rehabilitation of the maxilla, without recurring to any bone grafting procedure, was consecutively enrolled. The primary inclusion criteria were: informed consent from the participant, both full mouth bleeding on probing and a full mouth plaque index lower than or equal to 25%, the need for bone grafting, the refusal of a conventional sinus lift procedure, a residual alveolar crest of at least 5 mm in height and 4 mm in width distal to the first premolar, adequate bone volume in the tuberosity and pterigomaxillary regions in order to place an implant at least 10 mm long and 4 mm wide, and a stable occlusal relationship. Exclusion criteria were general medical (American Society of Anesthesiologist, class III or IV)[30] and/or psychiatric contraindications, pregnancy or nursing, absence of teeth/denture in the opposite jaw, severe bruxism or other destructive habits, radiation therapy to head or neck region in the previous 5 years, untreated periodontitis, poor oral hygiene and motivation, unavailability to attend regular follow-up visits, and an implant insertion torque ≤30 Ncm.

Surgical Protocol

A single 2 g dose of prophylactic antibiotic (amoxicillin and clavulanic acid, Augmentin, GlaxoSmithKline, Italy) was administered 1 h before surgery.[31] Patients were instructed to use chlorhexidine mouthwash 0.2% (Curasept, Curaden Healthcare, Milan, Italy) for 1 min, twice a day, starting 3 days prior to implant placement and thereafter for 1 week. All patients were intravenously sedated with 5 mg of diazepam (Valium, Roche, Milan, Italy). Local anesthesia was induced using 4% articaine chlorhydrate with adrenaline 1:100,000 (Alfacaina N, Weimer Pharma, Rastatt, Germany). A crestal incision was performed starting from the pterigomaxillary region and a mucoperiostal buccal flap was elevated, exposing the vestibular bony wall. Compromised teeth with a poor prognosis were atraumatically extracted and the socket was carefully debrided. Each patient received six implants according to the configuration already described in a previous report.[28] The most distal implants were placed throughout the posterior sinus wall with an inclination of 30 to 45 degrees relative to the occlusal plane. A direction pin was placed into the implant site and a radiograph was obtained to assess that the implants were correctly oriented. The medial implants were placed using a similar procedure along the anterior sinus wall. Finally, two straight implants were placed in the premaxilla area, in the position of the lateral incisors. In case of post-extraction implants,

fixtures were placed close to the palatal side, 1 mm deeper than the crest, and the remaining gap was filled with autogenous bone to reduce resorption.

All implants were placed according to the manufacturer's instructions; however, countersinking was avoided to engage as much cortical bone as possible. The diameter of the final drill was chosen in relation to the bone quality in order to optimize implant stability (Table 1). Bone density was assessed during the drilling phase by clinician's experience and sensation and it was based on Lekholm and Zarb classification.[32] In presence of D4 bone, the surgical site was typically underprepared with a 2.4 to 2.8 mm twist drill for the whole length, while in D3 bone quality, the last 3.2 mm drill was used only for the first 3 mm of the preparation to avoid any breakage of the most coronal bone during implant placement. Consequently, a minimum insertion torque of 30 Ncm was obtained (Table 2). After implant placement, angulated multi-unit abutments (Nobel Biocare AB) were connected to the tilted implants, while standard multi-unit abutments (Nobel Biocare AB) were connected to the two axial implants. Finally, the flap was closed with a 5-0 resorbable suture (Monocryl or Vicryl, Johnson & Johnson Medical, Pomezia, Italy). After implant placement, all patients received oral and written specific recommendations. Naprossene sodico 550 mg (Synflex Forte, Recordati, Italy) was prescribed every 6 to 8 h as needed.

Prosthetic Protocol

Immediately after implant placement, a plaster impression was taken at abutment level using an individual open tray, protecting the flaps with a sterile rubber dam positioned around the impression copings. Healing caps were placed on the abutments to support the peri-implant mucosa. A screw-retained, metal-reinforced, acrylic resin interim restoration was delivered within 4 h of surgery. All centric and lateral contacts were assessed by means of a 40 µm articulating paper (Bausch Articulating Paper, Köln, Germany), until light occlusal contacts, uniformly distributed on the entire prosthetic arch, were obtained.

Five to 6 months after the initial loading, in absence of pain and inflammatory signs a definitive computer-aided designed/computer-aided manufacturing, screw-retained, full-arch restoration was delivered (Procera Implant Bridge/Ti, Nobel Biocare AB). The restorations were screwed at abutments level according to the

TABLE 1 Distribution of Implants (Number and Percentage) According to Bone Quality and Fixture Length

	Axial Implants ($n = 64$) Fixture Length (mm)			Tilted Implants ASW ($n = 64$) Fixture Length (mm)			Tilted Implants PSW ($n = 64$) Fixture Length (mm)			
Bone Quality	11.5	13	15	11.5	13	15	11.5	13	15	Total
D1	0	3 (1.5%)	3 (1.5%)	0	3 (1.5%)	2 (1%)	0	0	0	11 (5.8%)
D2	4 (2.1%)	27 (14.1%)	11 (5.8%)	1 (0.5%)	18 (9.4%)	17 (8.9%)	0	14 (7.3%)	8 (4.2%)	100 (52.1%)
D3	8 (4.2%)	4 (2.1%)	4 (2.1%)	0	14 (7.3%)	8 (4.2%)	0	19 (9.8%)	12 (6.3%)	69 (36%)
D4	0	0	0	1 (0.5%)	0	0	0	9 (4.7%)	2 (1%)	12 (6.2%)
Total	12 (6.3%)	34 (17.7%)	18 (9.4%)	2 (1%)	35 (18.2%)	27 (14.1%)	0	42 (21.8%)	22 (11.5%)	192

ASW, anterior sinus wall; PSW, posterior sinus wall.

TABLE 2 Distribution of Implants (Number and Percentage) According to Insertion Torque and Fixture Length

	Axial Implants ($n = 64$) Fixture Length (mm)			Tilted Implants ASW ($n = 64$) Fixture Length (mm)			Tilted Implants PSW ($n = 64$) Fixture Length (mm)			
Insertion Torque (Ncm)	11.5	13	15	11.5	13	15	11.5	13	15	Total
35	0	0	1 (0.5%)	0	0	1 (0.5%)	0	0	0	2 (1%)
40	5 (2.6%)	9 (4.7%)	3 (1.5%)	1 (0.5%)	16 (8.3%)	5 (2.6%)	0	35 (18.2%)	13 (6.8%)	87 (45.3%)
50	5 (2.6%)	14 (7.3%)	7 (3.7%)	1 (0.5%)	11 (5.7%)	13 (6.8%)	0	6 (3.1%)	7 (3.7%)	64 (33.4%)
70	2 (1%)	11 (5.7%)	7 (3.7%)	0	8 (4.2%)	8 (4.2%)	0	1 (0.5%)	2 (1%)	39 (20.3%)
Total	12 (6.3%)	34 (17.7%)	18 (9.4%)	2 (1%)	35 (18.2%)	27 (14.1%)	0	42 (21.8%)	22 (11.5%)	192

ASW, anterior sinus wall; PSW, posterior sinus wall.

manufacturer's instructions. Patients were evaluated clinically and radiologically at each planned follow-up visit, and they were also enrolled in maintenance program every 3 months from surgery.

Outcome Measures

Primary outcome measures were failures of the implants and of the prostheses, and any biological (i.e., peri-implantitis, fistulas, or abscess) or biomechanical (i.e., fracture of the implant or prosthetic components) complication occurred until the end of the follow-up. A failed implant is an implant that has been removed, while a surviving implant is an implant that remains in the jaw and is stable, with no evidence of peri-implant radiolucency, no suppuration or pain at the implant site or ongoing pathologic processes.[33] Prosthesis success and survival rates were carefully examined following a modification of the evaluation criteria suggested by the California Dental Association.[34] Secondary outcome measures were marginal peri-implant bone level changes evaluated on intraoral radiographs taken with the parallel technique by means of a custom radiograph holder, and distances between implants, as well as distal cantilever were assessed on model casts. Periodontal parameters (plaque and bleeding indexes at implant level) were also recorded with time.

Marginal bone level changes were evaluated yearly for the entire 3-year follow-up. The baseline radiograph was at the delivery of the provisional prosthesis, 3 hours after suturing. Each radiograph was scanned at 600 dpi with a scanner (Epson Perfection Pro, Epson Italia, Cinisello Balsamo, Italy) and the marginal bone level was assessed with an image analysis software (UTHSCSA Image Tool version 3.00 for Windows, University of Texas Health Science Center, San Antonio, TX, USA) by two independent, experienced and blinded assessors. Software was calibrated for every image using implant size as a known distance and the calibration was checked by means of two measurements of fixture's diameter at different levels. Implant neck was used as reference for each measurement and the linear distance between the neck and the most coronal bone-to-implant contact was measured. Mesial and distal values were averaged so as to have a single value for each implant.

The distance from the center of the most anterior implant to a line joining the distal aspect of the two most posterior implants on each side, called the A-P distance or the A-P spread[35] has been measured. Moreover, the

mean distance between the platforms of the tilted implants on each side was measured. Both distances have been assessed on the master casts by means of parallelometer (Artiglio Snc, Parma, Italy).

Plaque and bleeding indexes were recorded at implant level every 6 months after implant placement.[36] Each implant was examined on four aspects (mesial, distal, vestibular, palatal). The percentage of sites in which plaque could be find, regardless its amount, was recorded. A total of 24 sites per patient were examined, as previously described.[28] Briefly, any site in which plaque could be detected by naked eye or with a probe accounted for 4.16% (1/24) of the total score (100%). The same was made for bleeding index, considering positive any site that showed bleeding on probing.

Patient's satisfaction in terms of aesthetics, phonetics, and masticatory function was recorded by means of a questionnaire before implant placement, at 6 months (before delivering the final prosthesis) and then at the 12-, 18- and 24-months follow-ups.[37] The answers were based on a 5-point Likert-type scale, with scores ranging from "poor" to "excellent" (1 = poor, 2 = sufficient, 3 = good, 4 = very good, 5 = excellent).

In order to reduce bias, the influence of implant morphology, smoking habits, and periodontal status prior to the treatment were considered regarding bone level changes over time. Two independent blinded assessors performed all data measures. In order to verify the reliability of the examiner, each evaluator measured twice a set of 10 randomly chosen radiographs, with 2 weeks interval between sessions. The second evaluator measured the same set of 10 random radiographs measured by the first examiner. The intra-examiner kappa coefficients were 0.87 and 0.9 (excellent agreement), while inter-examiner kappa coefficient was 0.79 (excellent agreement).

The statistical analysis was performed for numeric parameters using SPSS for Windows release 18.0 (SPSS Inc., Chicago, IL, USA). Descriptive analysis was performed using mean ± standard deviation. Bone loss around tilted and axial implants was compared using a paired *t*-test. Analysis of variance was used to analyze bone level changes over time. All statistical comparisons were conducted at the .05 level of significance. The null hypothesis was that there would be no difference in mean marginal bone changes between implants. Moreover, the data recorded by questionnaires were statistically analyzed by means of the Fisher's exact test.

RESULTS

A total of 32 patients were visited for eligibility. All patients (15 men and 17 women; mean age 58 ± 4.9 years; range 44–68 years) were consecutively enrolled in this study and the data collected were analyzed. Eleven patients were smokers with an average daily consumption of 8.2 cigarettes (range 5–10 cigarettes). No dropout occurred during the entire follow-up, and all data collected were evaluated in the statistical analysis. All patients were treated according to the allocated interventions with no deviation from the original protocol (Figures 1–7). A total of 192 implants (30 Brånemark System MK IV and 162 NobelSpeedy Groovy, Nobel Biocare AB) with moderately rough, highly crystalline, and phosphate-enriched titanium oxide surface (TiUnite, Nobel Biocare AB) were placed. Sixty-four axial implants and 128 tilted implants were placed, and all of them had a 4 mm platform. Forty-four implants (20 tilted and 24 axial) were inserted in fresh extraction sockets, immediately after reshaping of the crestal bone in order to obtain a flat bone anatomy. The axial implants had their platforms in extraction sites, achieving the required primary stability engaging at least 3 mm of healed bone, apical to the root apex. Eight out of 20 tilted implants engaged the extraction socket only in the most coronal part, while 12 implants were inserted through it only with their body.

All patient presented stable occlusal relationships, with an opposing arch composed by removable prostheses in six patients, natural teeth in seven patients, natural teeth and fixed prostheses on natural teeth in eight patients, fixed prostheses on natural teeth in six patients and natural teeth and two implant-supported partial prostheses in five patients.

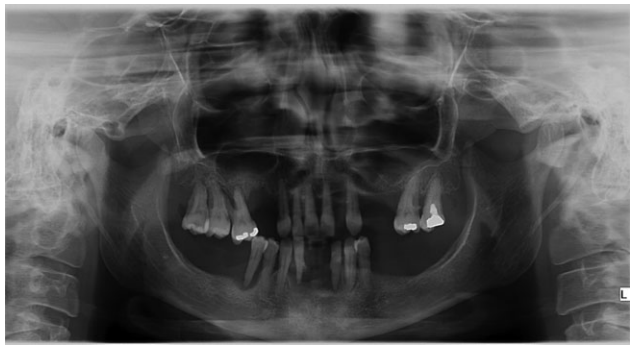

Figure 1 Panoramic x-ray evidenced severe bone loss due to the advanced generalized periodontitis. Extensive pneumatization of maxillary sinus in both sides did not allow implant insertion without a preliminary augmentation procedure.

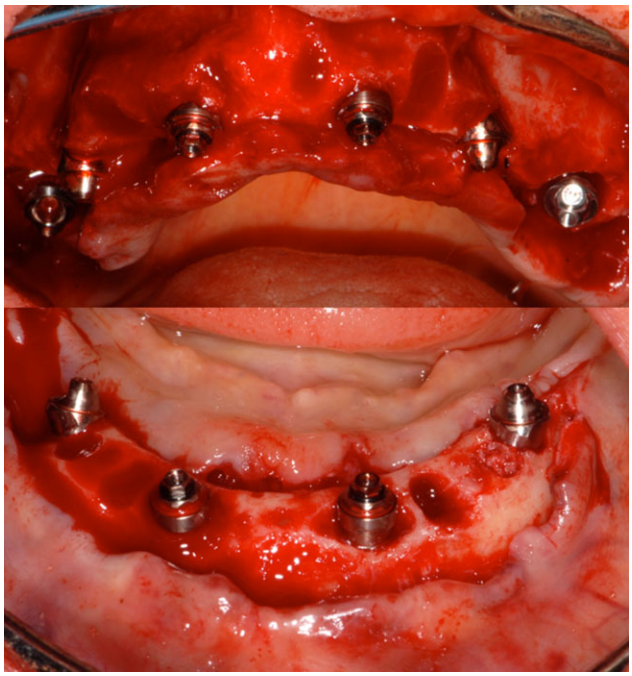

Figure 2 Surgical extraction and immediate implants placement in both jaws. Six implants were inserted in the maxilla and four fixtures in the mandible, accounting to the protocol. Thirty degrees angulated abutments were placed on posterior tilted implants, while straight abutments were screwed over axial anterior fixtures. Post-extraction gaps were filled with autogenous bone before flap closure.

All patients were followed for at least 3 years in function (range 36–78 months, average 55.53 months). Two tilted implants, parallel to the anterior and posterior sinus walls, were lost in two patients due to an infection after six months of loading, leading to a 98.44% implant survival rate for tilted implants. After 3 months of bone healing, both implants were successfully replaced in the same position, but they were not included in the statistical analysis. No axial implant failed, resulting in a cumulative implant survival rate of 98.96%. No prosthetic complication occurred resulting in a prosthetic survival and success rate of 100%.

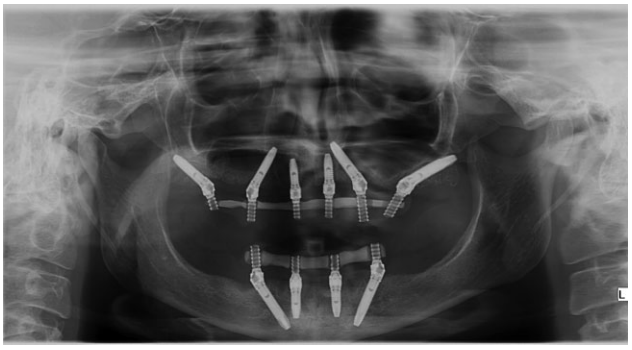

Figure 4 Orthopantomogram showing implants distribution and inclination.

During follow-ups, a mean marginal bone remodeling was assessed with no statistically significant difference ($p > .05$) between axial and all tilted implants ($p > .05$), as well as anterior and posterior sinus wall tilted implants ($p > .05$). Mean MBL around axial and tilted implants is shown in Tables 3 and 4. Ten axial and three tilted NobelSpeedy fixtures reported more than 2 mm of bone loss after 3 years of loading; all of them were placed in post-extraction sockets.

The mean A-P spread was 32.56 ± 5.87 mm (range 26.4–42.0 mm), while the mean distance between the platforms of the tilted implants on each side was 11.66 ± 3.07 mm (range 6.3–15.2 mm).

A significant reduction of plaque and bleeding scores was observed throughout the study, as reported in Table 5. All patients completed the questionnaires for satisfaction as reported in Table 6. At the last questionnaire, both aesthetics (regarding crown and soft tissues aspect and smile) and phonetics were judged as excellent or very good by 87.5% of patients, while masticatory function was considered excellent or very good by 90.6% of subjects.

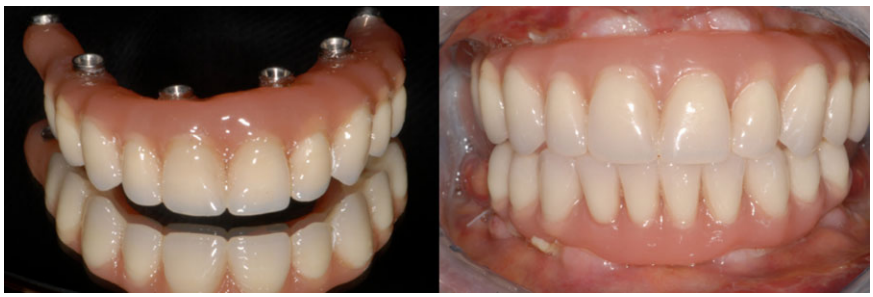

Figure 3 Provisional acrylic prostheses containing ten teeth were delivered the same day with full occlusal contacts limited between canines.

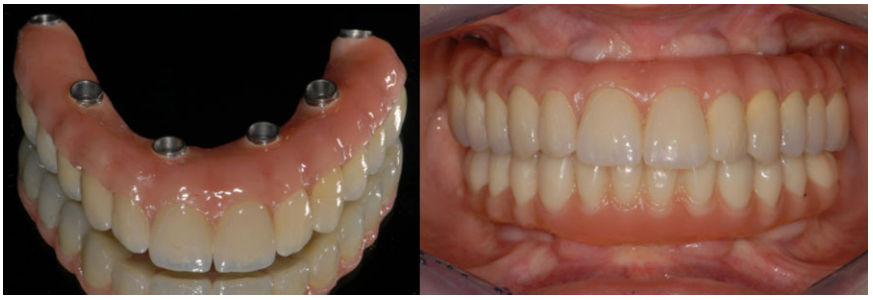

Figure 5 Maxillary prosthesis was realized with titanium framework and ceramic cemented crowns, while the lower jaw was restored with composite teeth.

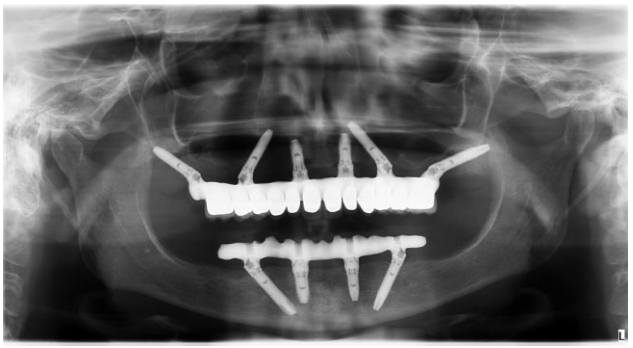

Figure 6 Orthopantomogram with final restorations based on CAD-CAM titanium frameworks.

DISCUSSION

The aim of this paper was to report new data of a previous study[28] evaluating a technique for the immediate rehabilitation of the edentulous maxilla with a full-arch fixed prosthesis supported by four tilted and two axial implants, after 3 years of function (range 36–78 months, average 55.53 months). Clinical and radiographic long-term results were very encouraging over time, with high level of patient satisfaction for both aesthetics and function. The cumulative implant survival rate was 98.44% up to 78-months follow-up. Two implants failed in two patients before delivering the final restoration bringing to a cumulative prosthetic survival and success rate of 100%. At the 3-year follow-up, marginal bone remodeling around axial and tilted implants was not significantly different.

The mean 1-year bone loss observed in this study is in line with the first report of this technique.[28] Comparing these results with a similar clinical study,[38] a higher bone resorption is evidenced because of an increased number of implants placed in post-extraction sites. After analyzing the data, only a limited number of fixtures had their platform in extraction sockets because bone regularization was necessary in all post-extraction cases. As a consequence, the intermediate and apical part of the socket remained intact and they are usually characterized by moderate or null dimensional changes.[39]

Agliardi and colleagues[26] reported 98.36% of survival rate from 61 edentulous maxillae rehabilitated by means of two anterior axial fixtures and two posterior tilted ones after a mean follow-up of 31 months. Malò and colleagues[40] showed 98.9% of survival rate for 166 implants at 1-year follow-up. Bergkvist and colleagues[41,42] treated 28 patients with six axial implants, for a total of 168 implants, reporting a survival rate of 98% after 8 months[41] and 97.5% after 5 years.[42] Kinsel and

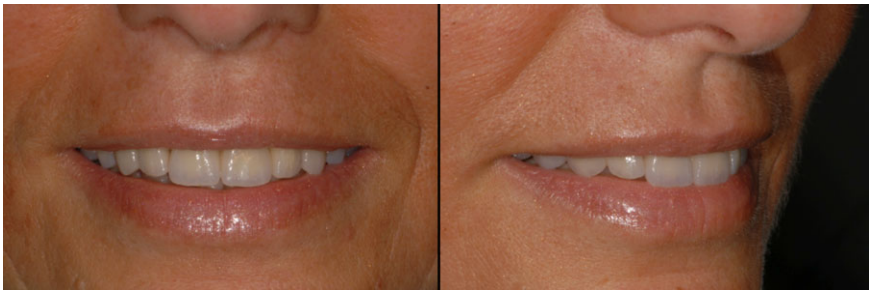

Figure 7 Frontal and later view of patient's smile with final restorations.

TABLE 3 Changes in Marginal Bone Level (mm) from Baseline to the 3-Year Follow-Up for Axial and Tilted Implants

	Axial ($n = 64$) Mean ± SD	Tilted ($n = 126$) Mean ± SD
1 year	1.07 ± 0.23	0.88 ± 0.16
2 years	1.21 ± 0.17	1.19 ± 0.18
3 years	1.55 ± 0.31	1.46 ± 0.19

Values for tilted implants are averaged data taken from both anterior and posterior sinus wall tilted implants. Mean values with 95% confidence interval. Differences between axial and tilted implants not statistically significant ($p > .05$).

TABLE 4 Changes in Marginal Bone Level (mm) from Baseline to the 3-Year Follow-up for Anterior and Posterior Sinus Wall Tilted Implants

	Tilted Implants ASW ($n = 63$) Mean ± SD	Tilted Implants PSW ($n = 63$) Mean ± SD
1 year	0.88 ± 0.13	0.89 ± 0.19
2 years	1.19 ± 0.17	1.18 ± 0.20
3 years	1.44 ± 0.16	1.47 ± 0.21

Mean values with 95% confidence interval. Differences between implants is not statistically significant ($p > .05$).
ASW, anterior sinus wall; PSW, posterior sinus wall.

Liss[43] placed a total of 261 implants in 39 maxillary arches with a survival rate of 94.3%. Finally, Degidi and colleagues[11] reported 98% at 5-year follow-up on 388 implants placed in 43 patients with an average of nine fixtures per maxillary arch.

Fifty-seven out of the 128 implants (44.5%) inserted in the posterior maxilla reached a minimum insertion torque of 50 Ncm. Such favorable results, obtained in mainly poor quality bone, might depend on the implant design, drilling protocol, and the specific surgical technique adopted for this kind of rehabilitation. Tilting of the implants engaging cortical sinus walls allows the placement of longer fixtures within compact bone, reaching high level of mechanical anchorage. A straight body with a conical narrow apex and aggressive threads produces an effect similar to an osteotome,[44] which in synergy with under preparing of the implant site, helps to achieve the required primary implant stability. However, the presence of adequate bone volume in the anterior and posterior wall regions of the maxillary sinus is a fundamental prerequisite for the application of the technique described here.

The ideal number of implants or their configuration to support an immediate fixed prosthesis has not been established yet. Although earlier studies on immediate loading involving a high number of fixtures especially in the maxilla have been published,[9,11,12] randomized clinical studies evaluating the effect of the number of implants on the treatment outcomes are still lacking. In the presented technique, four out of six implants emerge in the molar region (mean distance between tilted implants 11.66 ± 3.07 mm), where the concentration of the masticatory forces are higher. Furthermore, this configuration allows delivering a final prosthesis composed of 12 to 14 elements extended up to the second molar, without the need of distal cantilever. Even though a clear relationship between cantilever length and possible complications has not been defined yet[45] Shackleton and colleagues[46] reported lots of problems arising with cantilever longer than 15 mm. The anterior and posterior edentulous maxilla resorbs toward the palate after tooth loss. Consequently, implants often are placed lingual to the original position with the final restoration overcontoured facially due to the need of restoring the tooth position according to the aesthetics, speech, lip position, and occlusion, and thus, cantilevered forces on the anterior implant body. The treatment plan should provide increased implant support by increasing the number, design surface area and A-P spread in order to withstand the loading stresses that featured the occlusal pattern of

TABLE 5 Plaque Index (PI) and Bleeding Index (BI)

	6 Months (32 Patients)	12 Months (32 Patients)	18 Months (32 Patients)	24 Months (32 Patients)	36 Months (32 Patients)	48 Months (26 Patients)	60 Months (20 Patients)
PI (%)	18.07 ± 9.33	14.43 ± 8.18	13.78 ± 8.28	11.43 ± 7.05	8.12 ± 4.98	9.15 ± 5.67	12.1 ± 5.45
BI (%)	7.15 ± 4.38	5.85 ± 3.63	5.59 ± 3.75	4.68 ± 3.29	4.16 ± 2.58	5.2 ± 2.65	3.78 ± 3.45

Data are expressed as percentages as detailed in the text.

TABLE 6 Results of the Questionnaires for Patient's Satisfaction ($n = 32$)

	Baseline	6 Months	12 Months	24 Months
Aesthetics				
Excellent	4 (12.5%)	6 (18.75%)	9 (28.1%)	10 (31.25%)
Very good	14 (43.7%)	17 (53.1%)	17 (53.1%)	18 (56.25%)
Good	3 (9.4%)	7 (21.9%)	4 (12.5%)	3 (9.4%)
Sufficient	8 (25%)	2 (6.25%)	2 (6.3%)	1 (3.1%)
Poor	3 (9.4%)	0	0	0
Phonetics				
Excellent	6 (18.75%)	6 (18.75%)	8 (25%)	10 (31.2%)
Very good	16 (50%)	12 (37.5%)	18 (56.2%)	18 (56.3%)
Good	8 (25%)	10 (31.25%)	5 (15.7%)	4 (12.5%)
Sufficient	2 (6.25%)	4 (12.5%)	1 (3.1%)	0
Poor	0	0	0	0
Masticatory function				
Excellent	3 (9.4%)	7 (21.9%)	12 (37.5%)	13 (40.6%)
Very good	11 (34.3%)	17 (53.1%)	16 (50%)	16 (50%)
Good	7 (21.9%)	5 (15.6%)	4 (12.5%)	3 (9.4%)
Sufficient	7 (21.9%)	3 (9.4%)	0	0
Poor	4 (12.5%)	0	0	0

Comparisons	Aesthetics	Phonetics	Masticatory function
Fisher's exact test			
Baseline versus 6 months	0.067	0.69	0.066
6 months versus 12 months	0.69	0.19	0.256
Baseline versus 12 months	0.06	0.69	0.0005
12 months versus 24 months	0.96	0.85	0.94
Baseline versus 24 months	0.016	0.22	0.0002

the edentulous patients with atrophic maxilla, restored with an fixed full-arch implant-supported restoration.

Patient's satisfaction concerning aesthetics, phonetics, and function was very high throughout the study. A significant improvement in aesthetics has been registered from baseline to 6 months, corresponding to the main change from an initial scenario of total edentulism or partial edentate one to a fixed immediate prosthesis with aligned teeth. No influence on phonetics have been noticed by patients, meaning that the space for the tongue was not violated, while eating comfort reported a significant subjective improvement from surgery to provisional and again, when additional posterior teeth were provided with the definitive prostheses.

CONCLUSION

Within the limitations of this study, the successful medium-term results obtained seem to confirm that immediate fixed full-arch rehabilitations, supported by six implants with these configurations, could be an effective and biologically beneficial alternative to augmentation of the maxillary sinus floor for the immediate restoration of the edentulous maxilla avoiding bone grafting procedures.

DISCLOSURE

The authors declare that they have no conflicts of interest in this study.

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