

IMPACT OF A RIGID ORAL HYGIENE MAINTENANCE PROGRAM ON PERI-IMPLANT TISSUE HEALTH: RETROSPECTIVE ANALYSIS OF A 3-YEAR CLINICAL AND RADIOLOGICAL FOLLOW-UP OF IMPLANTS SUPPORTING ALL-ON-4 FULL-ARCH RESTORATIONS

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SUMMARY

Objective. Good peri-implant tissue-health indicates that an implant is well-osseointegrated, the marginal bone levels are being maintained, and it maximizes the esthetic outcome of the restoration. This retrospective study investigated the impact of a rigid hygiene maintenance program and implant design on bone levels and peri-implant mucosa health.

Methods. The study included edentulous patients who received a full-arch implant-supported prosthesis and who reported for the 3-year follow-up. Here reported are clinical and radiological outcomes as well as patient satisfaction.

Results. 112 variable-thread tapered implants were placed in 28 patients according to the All-on-4 treatment concept. At 3 years, all implants were stable and the implant survival rate was 100%. The mean marginal bone level was -0.92 ± 0.79 mm at baseline and -0.94 ± 0.92 mm at the 3-year follow-up. All patients had healthy peri-implant mucosa with no signs of bleeding or visible inflammation. In addition, there were no signs of plaque on any of the prostheses. No adverse events were reported during the study period.

Conclusion. Three years post-implant placement, there was no marginal bone loss and the soft tissue exhibited excellent health, suggesting that combining good oral hygiene maintenance with an implant geometry designed to positively impact bone response can demonstrate excellent clinical and radiological outcomes.

Key words: All-on-4, oral hygiene.

Introduction

The All-on-4 treatment concept for rehabilitating fully edentulous arches was first described by Malò et al. in 2003 (1). In the All-on-4 treatment concept, the prosthesis is supported by four implants placed in cornerstone positions in the

anterior region of the jaw, either the mandible or the maxilla. The two anterior implants are placed axially to the occlusal plane. The remaining two implants are placed posterior to the axial implants and tilted distally (1). From a biomechanical standpoint, tilted implants engage more cortical bone, making it more stable and allowing a graftless solution with distal prosthetic support.

Tilting also reduces stress on the prosthesis and improves load distribution, which reduces micromotion and stress at the marginal bone level (2). Indeed, according to a recent systematic review, the All-on-4 treatment concept has been documented to result in a good peri-implant bone response, with cumulative bone loss of 1.3 mm at 3 years of follow-up (3).

Peri-implant tissue health is one of the key predictors of the success of implant therapy. Healthy peri-implant hard- and soft tissue indicates that an implant is well osseointegrated, the marginal bone levels are being maintained, and it maximizes the esthetic outcome of the restoration. This retrospective study investigated outcomes around implants placed according to the All-on-4 treatment concept in protocols geared towards supporting good peri-implant tissue health through implant design and a rigid oral hygiene maintenance program. The study implant design includes a back-tapered collar, which has been credited with healthy bone response possibly associated with less pressure on cortical bone (4) and an internal conical connection, which has been shown to result in improved peri-implant tissue health attributed to better abutment fit, stability, and seal performance (5). Post surgery, all patients have been subjected to a rigid oral hygiene maintenance program to support good tissue health (6). This manuscript reports clinical and radiological outcomes as well as patient satisfaction recorded in the study.

Materials and methods

This retrospective, non-interventional analysis included edentulous patients who received a full-arch implant-supported prosthesis between January 12, 2010 and January 18, 2011 and who reported for the 3-year follow-up visit at a private practice clinic located in Desenzano del Garda, Italy. Implants (NobelActive; Nobel Biocare AB, Göteborg, Sweden) were placed in healed sites and immediately loaded with full-arch, fixed, provisional acrylic prostheses according to the All-on-4 treatment concept. Pa-

tients were excluded from the treatment only if they had severe contraindications for implant placement.

One hour before surgery, patients were given 2 g of amoxicillin and 1 g was given 8 hours post-operatively. Anti-inflammatory medication (ibuprofene 600 mg) was administered 30 minutes prior to surgery, 6 hours after the surgery, and twice daily for 4 days thereafter. Oral disinfection was performed using a 0.2% chlorhexidine digluconate mouthwash prior to surgery and thereafter three times daily for 2 weeks.

Implants were either narrow platform (NP) or regular platform (RP) and were inserted according to manufacturer's instructions. All implants received multi-unit abutments (MUA; Nobel Biocare AB) connected at surgery and were immediately loaded with a full acrylic provisional bridge. Permanent, screw-retained prostheses were Procera titanium bar (Nobel Biocare AB) with acrylic resin or full acrylic bridge, and were placed on the original MUAs 2 to 7 months after implant insertion. Implant stability, peri-implant mucosa health (bleeding upon probing and visible inflammation including redness and swelling), presence of plaque, adverse events, and patient satisfaction were evaluated during regular 4-month follow-ups.

Periapical radiographs were collected at the time of implant placement (baseline) and the 3-year follow-up. Bone levels were measured by an independent radiologist (University of Göteborg, Sweden) and calculated using the following formula: (mesial + distal)/2. Negative numbers indicate bone levels apical to the implant-abutment junction, which was defined as the reference point. Marginal bone level change was calculated from paired radiographs. Bone level change was calculated as the difference between bone levels at two time-points (baseline and 3 years). The mesial and distal sides of the implant were calculated separately, and then the values were averaged to calculate overall bone level change for each implant site. Negative numbers indicate bone loss, and positive numbers indicate bone gain.

Statistical analyses were performed in SPSS version 22 (IBM, Armonk, NY) by an independent

statistician (Statistiska Konsultgruppen, Göteborg, Sweden). The significance of bone level change between baseline and 3-year follow-up was tested using the Wilcoxon Signed Rank test. The significance of bone level change with respect to implant angle and the jaw in which the implants were placed was tested using a mixed model with additive predictors. Patient variance was adjusted for per-patient random effects. The significance for fixed effects were determined using t-tests.

Results

In the present study, 28 edentulous patients (11 females and 17 males) with a mean age of 65.9 ± 8 years received 4 implants each (112 implants total) to support a mandibular (20 patients, 71.4%) or maxillary (8 patients, 28.6%) All-on-4 full-arch prosthesis. 18 patients (64.3%) had a thick and 10 patients (38.7%) had a thin mucosal biotype.

Information on implant position and characteristics are provided in Table 1. The most common locations for axial implants were the lateral incisors (Federation Dentaire Internationale [FDI] position 12 and 22 for maxillary prostheses, FDI-position 32 and 42 for mandibular prostheses). The most common locations for the emergence of tilted implants were the second premolars (FDI-positions 15, 25, 35 and 45). The mean insertion torque was 63.4 ± 8.5 Ncm (range, 45-70 Ncm). All implants were immediately loaded with a provisional full acrylic bridge. Final prostheses were placed a mean 2-3 months (range, 2-7 months) after implant placement and were Pro-cera titanium bar (27 patients) with acrylic resin. In one patient, the provisional full acrylic bridge was never replaced. Mean patient follow-up was 38.3 ± 3.7 months (range, 32-43 months).

At 3 years, all implants were stable and the implant survival rate was 100%. The mean marginal bone level was -0.92 ± 0.79 mm at baseline and -0.94 ± 0.92 mm at the 3-year follow-up. The mean marginal bone level change at last follow-up was -0.02 ± 0.90 mm (Table 2). One implant

Table 1 - Baseline implant characteristics.

Characteristic	Distribution (%)
Diameter	
RP	87 (77.7)
NP	25 (22.3)
Jaw	
Maxilla	32 (28.6)
Mandible	80 (71.4)
Position	
Central incisor	3 (2.7)
Lateral incisor	48 (42.9)
Canine	5 (4.5)
First premolar	2 (1.8)
Second premolar	44 (39.3)
First molar	10 (8.9)
RP, regular platform; NP, narrow platform	

Table 2 - Distribution of marginal bone level changes between baseline and the 3-year follow-up.

Baseline to 3 years		
Mean (mm)	-0.02	
S.D.	0.90	
n	111	
Distribution (mm)	n	%
> 3.0	1	0.9
2.1 – 3.0	2	1.8
1.1 – 2.0	5	4.5
0.1 – 1.0	45	40.5
0	11	9.9
-1.0 – -0.1	37	33.3
-2.0 – -1.1	7	6.3
-3.0 – -2.1	3	2.7
Total	111	100.0

was excluded from the analysis due to the low quality of the baseline radiograph. 57.6% of patients had no bone loss or showed bone gain at the 3-year follow-up, and 33.3% had less than 1 mm bone loss. As shown in the Table 2, the mean bone level change at axial implants (n=55) was -0.01 ± 1.15 mm and at tilted implants (n=56) was -0.02 ± 0.59 mm. The difference in bone level changes between the two implant angle groups was not significant ($p=0.32$). The mean bone level change at maxillary implants (n=32) was 0.17 ± 1.15 mm and at mandibular implants (n=79) was -0.09 ± 0.80 mm. The difference in bone level changes with respect to the jaw in which the implants were placed was not significant ($p=0.93$).

At the 3-year follow-up, all 28 patients had healthy peri-implant mucosa with no signs of bleeding or visible inflammation. In addition, there were no signs of plaque on any of the prostheses. No adverse events were reported during the study period. An example of the surgical and restorative protocol is depicted in Figures 1-5. When asked about their satisfaction with the prosthesis, patients reported that they were satis-

fied or very satisfied with the appearance and function. The only documented patient complaint was difficulty keeping the prosthesis clean. This complaint was reported mostly by elderly patients.

Discussion

This study evaluated variable-thread tapered implants used to treat fully edentulous arches according to the All-on-4 treatment concept in either jaw. At the 3-year follow-up, the implants showed a 100% survival rate and excellent hard- and soft-tissue outcomes.

Publications reporting the clinical outcomes of the All-on-4 treatment concept describe good clinical results. The 17 All-on-4 studies identified by a systematic review by Patzelt et al. demonstrate an implant survival rate range of 94.8-100% with up to 11 years of follow-up (3). Among the studies reporting 3-year follow-up results, implant survival ranged from 97.5 to 100% while the bone level changes ranged from



Figure 1
Representative case: clinical view of hopeless mandibular dentition prior to treatment.

-0.85 mm to -1.52 mm (3). In comparison with these results, the 100% implant survival and no bone loss at the 3-year follow-up observed in the current study indicate that the chosen surgical protocol, combined with a careful patient selection, the study implant design with its back taper and conical connection, and the high frequency of follow-up visits may favor improved clinical outcomes. Of interest, the excellent bone response observed in the current study was inde-

pendent of the jaw or implant orientation.

In other studies (7-18) in which patients received variable-thread tapered implants and were treated according to the All-on-4 treatment concept, the lowest implant survival rate was 97.4% at a mean follow-up of 2 years (8) and the highest rate of 100% at a mean follow-up of 2.1 years (14). With respect to marginal bone level changes, only 3 studies present such analysis showing -0.72 mm at 1 year (14), -0.14 mm at 1.3 year (10), and -1.08 mm at 3.6 years (18). In this context, the results of the current study demonstrating a 100% survival and no bone loss (mean bone level change of -0.01 ± 1.15 mm) are particularly favorable. One factor which has likely contributed to these excellent results is the good tissue health prior to implantation. Good soft tissue response was also likely a result of placing the final abutment already at the stage of provisional prosthesis, i.e., the MUAs were never removed and thus the soft tissue attachment that has formed was never disturbed. Furthermore, the lack of plaque, inflammation, and bleeding upon probing at last follow-up indicates that the patients maintained very good oral hygiene and retained the good peri-implant tissue health.

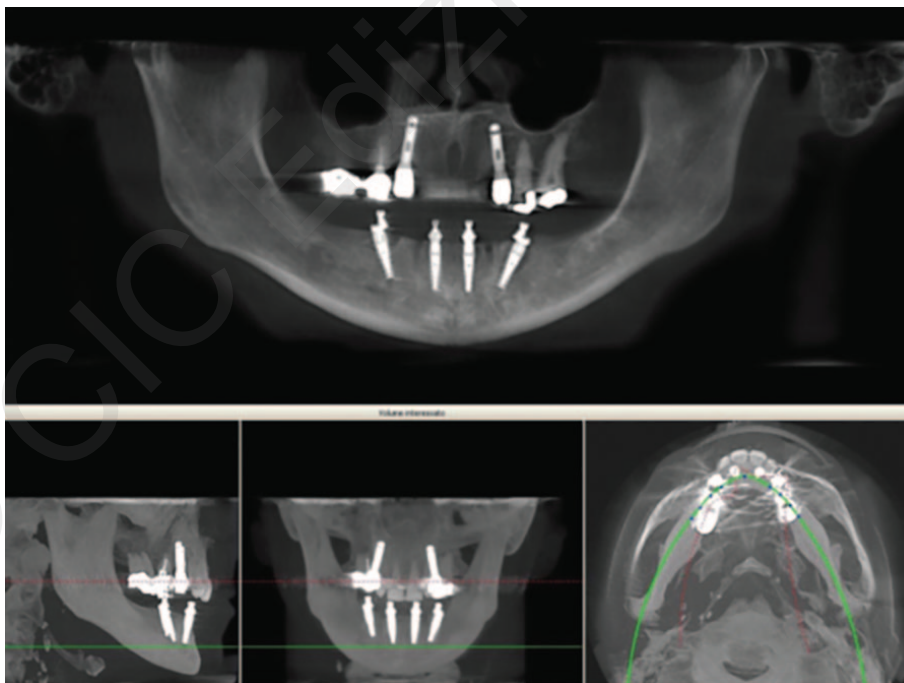


Figure 2
Post-operative CT scan after implant placement 3 months after tooth extraction. Four variable-thread tapered implants were placed at lateral incisor and second premolar positions (FDI positions 45, 42, 32, and 35).



Figure 3
Clinical labial and occlusal view after implant placement.



Figure 4
Clinical occlusal view after implant placement.



Figure 5
Clinical view at final prosthesis delivery.

Another contributing factor may be the rigid follow-up schedule, since patients were invited to the clinic every 4 months as part of the regular treatment regime. Indeed, studies evaluating outcomes when patients were enrolled in a supportive post-implant therapy program with a 3-month recall showed that regular follow-up positively impacts bone level changes (19), likely due to increased compliance with post-surgical care and oral hygiene protocols. Further investigations are needed to identify the factors associated with the healthy bone response observed in this study.

Beyond clinical outcomes, this study demonstrates high patient satisfaction with the All-on-4 treatment concept. When asked, the patients were satisfied with both the esthetics and the function of the restorations. The only complaint recorded was that some patients found the restoration difficult to keep clean. Notably, those patients who had difficulty cleaning were also among the oldest in the study. It is likely that the reduced mobility and fine motor function associated with old age may affect the patient's ability to care for their prosthesis (20). This observation may need to be integrated into the decision-making process when determining whether to proceed with implant-supported full-arch restorations.

The limitations of this study include its retrospective nature and lack of quantitative assessment of patient satisfaction. Because the study is retrospective, the information provided in patient charts was limited and may not be comprehensive. Lack of quantitative assessment of patient satisfaction makes it difficult to compare the results in the current study with those of other studies.

Conclusion

Variable-thread tapered implants used in both jaws according to the All-on-4 treatment concept combined with frequent follow-up visits to maintain good oral hygiene show no marginal bone loss, excellent peri-implant soft tissue health, and high patient satisfaction, thus representing a safe and predictable option for edentulous patients.

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