AESTHETIC VERSUS SURGICAL SUCCESS OF SINGLE DENTAL IMPLANTS: 1- TO 9-YEAR FOLLOW-UP

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Anterior maxillary implantation is a challenging treatment. The authors examined the aesthetic and surgical success of a single dental implant in the anterior by studying 52 implants with a mean follow-up of 37.5 months. Marginal bone loss (MBL), aesthetic parameters, and examiners' satisfaction from the aesthetic outcome were examined. The total surgical survival and success rates as well as the average examiner's aesthetic satisfaction and success rates are presented. Implantation in the anterior has high surgical survival and success rates, as well as a considerably high aesthetic success rate. The high surgical success and survival rates cannot, however, predict aesthetic success.

Learning Objectives:

The aesthetic and surgical success of a single dental implant in the anterior was examined by studying 52 implants with a mean follow-up of 37.5 months. Upon reading this article, the reader should:

- Gain the awareness that interior implantation can have high surgical survival and success rates, as well as a considerably high aesthetic success rate.
- Understand that bone loss can occur with a satisfactory aesthetic result and that high surgical success and survival rates do not predict aesthetic success.

Key Words: implants, aesthetics, anterior maxilla, marginal bone loss (MBL)

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The anterior maxillary region is the most traumatized region and most exposed to habits.[1-3] The use of a dental implant to replace a single tooth is considered a predictable and successful treatment.[4-9] Nevertheless, to replace a missing single anterior maxillary tooth with a dental implant is a challenge because of the high aesthetic, functional, and biological demands.[10,11] In the anterior maxilla, the alveolar ridge dimensions influence implant location, position of the lip, and the architecture of the free gingival margin (FGM).[12,13] Additionally, a single tooth replaced with a dental implant in this region has specific problems, such as labial plate resorption,[14] a relatively young patient age,[1,15] and a high aesthetic demand.[16] Aesthetic results are affected by several factors, such as gingival profile including the interdental papilla shape and the accurate FGM,[17-19] smile-line harmony,[20] and the aesthetic emergence angle.[21]

The purpose of this study was to compare the traditional surgical survival and success criteria with distinct aesthetic parameters following anterior maxillary single implant placement.

Subjects and Methods

The study group consisted of 48 patients (29 female, 19 male), aged from 18 to 65 years (mean of 36.2 years), who were treated between the years 1991 and 1998. A total of 52 threaded implants (10 hydroxyapatite-coated, or 19.2%, and 42 pure titanium implants, or 80.8%) were placed in the anterior maxilla to replace a single missing tooth.

Patients were selected if they 1) had a single anterior implant between two adjacent teeth in the premaxilla region replacing a central or a lateral incisor; 2) were healthy adults with at least 12 months of follow-up after rehabilitation continued by yearly follow-ups, up to 9 years postimplantation; and 3) had both intraoral and extraoral clinical photographs and periapical radiographs taken at each follow-up visit.

Figure 1. Labial view of left anterior central incisor, 10 years postrehabilitation.

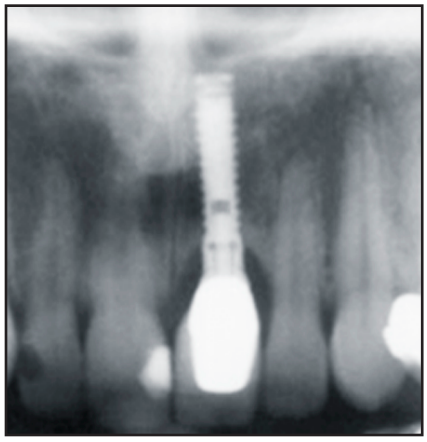

Figure 2. Radiographic view of left anterior central incisor, 10 years postrehabilitation.

Figure 3. Labial view of left anterior central incisor of a second patient, 1 year postrehabilitation depicting satisfactory aesthetic parameters marked as "Perfect" (aesthetic and surgical success).

Figure 4. Labial view of right lateral incisor, 2 years postrehabilitation demonstrating aesthetic failure. Aesthetic parameters were not satisfactory (marked as "Failure"). Interdental papillae shape: papillae filled the entire proximal space and in good harmony with adjacent papillae. Free gingival margin: accurate form in harmony with adjacent teeth. Attached gingival appearance: occlusogingival height similar to adjacent teeth with stipple appearance.

Figure 5. Periapical radiographic view demonstrating no marginal bone loss 2 years postrehabilitation.

One dental surgeon carried out all surgeries in one clinic. There were 26 (50%) implants placed immediately after tooth extraction and 26 (50%) placed 6 months or more after extraction. The "procedure without incision" technique described by Schwartz-Arad and Chaushu[22] was used to place 9 of the immediate implants. The traditional two-stage technique with primary closure[23] was used to place the remaining implants. Follow-up (from time of implant exposure) ranged from 12 to 109 months, or 1 to 9 years (average 37.53 months).

Surgical Success—Marginal Bone Loss

Marginal bone loss was measured on periapical radiographs using the implant threads as the dimensional reference, a technique formally suggested by Hass et al.[6] The number of threads unsupported with bone in both the mesial and distal aspects of each implant were counted, and the higher number of each was taken for bone loss calculation. Information concerning the pitch of different implant systems was received from the manufacturers. Evaluation of MBL was made by subtracting the bone level of each implant at the time of implant exposure with that of the most recent follow-up.

A modification to the criteria suggested by Alberktsson et al,[24] Smith and Zarb,[25] and Alberktsson and Zarb[26] was used to evaluate implant success. An implant was considered successful if it had survived and its MBL was less than 0.2 mm per year after 12 months following this procedure.

Aesthetic Examination

Three dental professionals independently conducted the aesthetic examinations by projecting the clinical slides (ratio 1:1 or 1:2) of each rehabilitated implant on a screen. Aesthetic success was examined according to the examiners' satisfaction (ie, sufficient or insufficient) and the following aesthetic parameters[15]:

1. Interdental papillae shape—Papillae filled the entire proximal space and/or in good harmony with adjacent papillae.[27]
2. Free gingival margin—Accurate form in harmony with adjacent teeth.
3. Attached gingival appearance—Occlusal-gingival height similar to neighboring teeth with stipple appearance.

Table 1

Cumulative Implant Success Rate (Kaplan-Meier)

Time (Years)	Number of Implants	Failed	CSR %
1-2	51	1	97.6
2-3	39	0	97.6
3-4	29	0	97.6
4-5	19	1	92.6
5-9	13	0	92.6

Table 2

Examiners' Rating for Aesthetic Parameters

Aesthetic Parameter	Criteria Fullfillment	Percentage
Interdental papilla	43	84.3
Free gingival margin	38	74.5
Attached gingival appearance	42	82.4
Smile-line harmony	44	86.3
Total	51	100

4. Smile line—Harmony with the restoration.

The mean aesthetic evaluation of the three examiners was then divided into four categories:

1. Failure—More than two aesthetic parameters were unsatisfactory.
2. Fairly good—Two aesthetic parameters were unsatisfactory.
3. Good—One aesthetic parameter was unsatisfactory.
4. Perfect—All aesthetic parameters were satisfactory.

Aesthetic success was defined as "Good" or "Perfect" (Figures 1 through 3), and aesthetic failure was defined as "Fairly good" or "Failure" (Figures 4 and 5). Life table analysis was conducted by Kaplan-Meier, Pearson's Chi square test, analysis of variance (ANOVA), Fisher exact test (ie, two-tail), and a stepwise logistic regression test was performed using the SPSS 10.0 (ie, SPSS, Inc., Chicago, IL).

Results

Regarding surgical success, the 9 years' cumulative survival rate was 98.1%; 1 implant failed before loading. Average implant length and width were 15.02 mm and 3.82 mm, respectively. The surgical success rate (as determined by MBL) was 96.1% (49/51) and the cumulative success rate at 9 years was 92.6% (Table 1).

Table 3

Aesthetic Marks

Aesthetic Success	Number of Implants (%)	Mark	Number of Implants	Percentage
+	42 (82.4)	Perfect	33	64.7
		Good	9	17.6
–	9 (17.6)	Fairly good	3	5.9
		Failure	6	11.8
Total	51 (100)		51	100

Table 4

Correction Between Examiners' Aesthetic Satisfaction and Aesthetic Parameters

	p-value Fisher Exact Test (2-tail)	*p*-value Pearson Chi Square Test
Satisfaction/papilla	0.0010	0.000
Satisfaction/free gingival margin	0.0001	0.000
Satisfaction/attached gingival appearance	0.0002	0.000
Satisfaction/smile-line harmony	0.0000	0.000

The examiners' aesthetic satisfaction rate was 86.3% (44/51 implants). Table 2 describes the examiners' rating for the different aesthetic parameters. The average aesthetic success (marked "Good" or "Perfect") was 82.4% (42/51) (Table 3).

There was a statistically significant relation between the examiners' aesthetic satisfaction and each aesthetic parameter (eg, interdental papilla, FGM, attached gingiva, smile-line harmony) (Table 4). According to the stepwise logistic regression test, the smile-line harmony was the most important aesthetic parameter influencing the aesthetic satisfaction rate (odds ratio = 0.004).

A statistically significant relation was also found between aesthetic success and each aesthetic parameter ($p<0.001$). The most important aesthetic parameter that influenced aesthetic success was interdental papilla followed by attached gingiva (odds ratio = 0.016 and 0.035, respectively).

There was a significant relation between examiners' aesthetic satisfaction and aesthetic success ($p<0.001$). No correlation was found between MBL and any of the aesthetic criteria.

Discussion

Surgical survival and success rates were high, as expected, similar to other results in previous studies,[4-6] which showed that implantation in the anterior maxillary area is a predictable surgical procedure. The aesthetic satisfaction rate was lower than expected, however, probably due to the fact that 3 examiners determined it according to very distinct aesthetic parameters and patient satisfaction was not considered. In one study, the aesthetic satisfaction rate reported by patients was much higher than the satisfaction rate recorded by clinicians.[28]

It is noteworthy that in the present study, the aesthetic success did not consider parameters that could be corrected, such as crown color and shape. Avivi-Arber and Zarb[8] tested implants that replaced a single tooth and claimed that the impaired aesthetic results were influenced by unsuitable restoration color and form, and reflection of the superstructure in the subgingiva. It was noted that the result could easily be changed by replacing the unsuitable restoration. Groisman et al[9] found that a long occlusogingival restoration dimension and unaesthetic soft tissue around the restoration were the most frequent aesthetic complications. In the present study, interdental papilla shape and FGM affected aesthetic failure. There are several reports regarding FGM recession after implant second-stage surgery, which explains the changes in the FGM location.[27] Bengasi et al[29] have shown that 2 years after insertion of fixed prostheses, gingival recession is present mainly in the labial aspect of the maxillary area. Nevertheless, Scheller et al[4] found differences in the relation between restoration and soft tissue, but concluded that the soft tissue remains stable and that implants can be safely used for tissue-integrated replacement of a single tooth. Jovanovic et al[18] discusses the conditions for obtaining an optimal papilla, such as an optimal mesiodistal space between implant and tooth from 1.5 mm to 2 mm. Several surgical procedures used to improve the papilla and soft tissue surgical and aesthetic results are described in the literature.[30,31] According to Jemt,[27] however, there was complete spontaneous recovery of the papilla without any special surgical procedure or clinical manipulation in 58% of single implants. In the present study, the 1- to-9-year follow-up probably describes the result after completion of the initial gingival changes, thus revealing the final aesthetic appearance. Papilla shape and attached gingiva appearance were the most important parameters influencing aesthetic success. Nevertheless, aesthetic satisfaction was primarily influenced by smile-line harmony. These factors should be considered when dental implants are used to replace a missing single tooth, especially in the anterior maxillary area.

Interestingly, in the present study, there was no significant relation between MBL and aesthetic satisfaction or success. This means that bone loss can occur with a satisfactory aesthetic result. The clinician should be aware of the fact that MBL might not influence or impair the aesthetic result.

In this study, bone loss did not impact the aesthetic outcome. This could be attributed, among other causes, to the periotype thickness which was not studied in the present study. Further research is warranted.

Conclusions

Implantation in the anterior maxillary area is a predictable procedure with high survival, surgical, and aesthetic success rates. Nevertheless, high surgical success and survival rates do not predict aesthetic success. Marginal bone loss can occur even with a satisfactory aesthetic result.

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Continuing Education (CE) Exercise No. X

To submit your CE Exercise answers, please use the answer sheet found within the CE Editorial Section of this issue and complete as follows: 1) Identify the article; 2) Place an X in the appropriate box for each question of each exercise; 3) Clip answer sheet from the page and mail it to the CE Department at Montage Media Corporation. For further instructions, please refer to the CE Editorial Section.

The 10 multiple-choice questions for this Continuing Education (CE) exercise are based on the article, "Aesthetic versus surgical success of single dental implants: 1- to 9- year follow up," by Liran Levin, DMD, Sagit Pathael, DMD, Eran Dolev, DMD, and Devorah Schwartz-Arad, DMD, PhD. This article is on pages 000-000.

1. What was the aim of this work?
a. Evaluation of surgical and aesthetic success of implants.
b. Evaluation of bone loss around dental implants.
c. Evaluation of appearance of dental implants over time.

2. What method was used to evaluate surgical success?
a. Implant mobility.
b. Implant function.
c. Clinically observed bone level.
d. Radiographic marginal bone loss.

3. What was the total survival rate?
a. 92.6%.
b. 98.1%.
c. 97.6%.
d. 82.4%.

4. What was the cumulative survival rate after 5 to 9 years?
a. 92.6%.
b. 98.1%.
c. 97.6%.
d. 82.4%.

5. What was the average aesthetic success rate?
a. 92.6%.
b. 98.1%.
c. 97.6%.
d. 82.4%.

6. Which implants were examined?
a. Implant replacing anterior aesthetic teeth.
b. Implant replacing single molars.
c. Implant replacing single anterior maxillary tooth.
d. Implant replacing teeth in the anterior segment between premolars.

7. What aesthetic parameters were NOT used in this work?
a. Interdental papilla appearance.
b. Free gingival margin.
c. Tooth color.
d. Smile-line harmony.
e. Attached gingival appearance.

8. Can aesthetic success predict the surgical success (bone loss) according to this paper?
a. Yes.
b. No.

9. Can bone loss predict the aesthetic success according to this paper?
a. Yes.
b. No.

10. Which parameter was affected the most on the aesthetic failure?
a. Free gingival margin.
b. Tooth color.
c. Smile-line harmony.
d. Attached gingival appearance.