Treatment Outcome of Dental Implants in the Esthetic Zone: A 12- to 15-Year Retrospective Study

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In the mid-nineties, 27 patients received 31 implant-supported crowns in the anterior maxillary region, and 12 to 15 years later, 18 patients (67%) with 22 implants (67%) participated in a retrospective study evaluating implant survival, bone loss, prosthetic complications, patient satisfaction, and patient and professional evaluation of esthetics. One implant was lost because of implant fracture after 10 years. Mean marginal bone loss was 1.53 mm (standard error ± 0.17 mm). In 6 patients, 6 crowns were replaced and 1 repaired. In 3 patients, 3 crowns had minor unrepaired porcelain fractures. Implant survival was 95.5%, and, despite the high frequency of prosthetic complications, patients were generally very satisfied with the long-term treatment outcome. *Int J Prosthodont 2013;26:365–369. doi: 10.11607/ijp.3097*

As implant treatment has become a common option, long-term follow-up is of great importance to predict long-term treatment outcomes. A high number of studies with an observation time between 1 and 5 years have analyzed the survival and success of dental implants, but long-term follow-up studies on dental implants in the esthetic zone are sparse.[1–4] The aim of this retrospective study was to evaluate the treatment outcome 12 to 15 years after placement of implant-supported crowns in the esthetic zone.

Materials and Methods

Twenty-seven consecutive healthy patients free from periodontal disease were treated with 31 dental implants (Implant Innovations) inserted into the anterior maxilla by the same surgeon from 1993 to 1995 following a standard two-stage surgical procedure.[5] All 27 patients were approached after 15 to 17 years, and 18 patients (67%) with 22 implants (67%) agreed to participate and gave their informed consent. Dropout was caused by withdrawal from the original study (2), moving out of town (2), disease (1), unwillingness to participate (1), or irretrievability (3).

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Patient age at implant placement ranged from 17 to 41 years, and the male/female ratio was 11/7 (Table 1). All but two patients had one single implant (3.75 mm in diameter) replacing a maxillary incisor. The remaining two patients each had three adjacent implants, (maxillary left central incisor to canine and maxillary right central incisor to left lateral incisor), which in one patient were splinted. In the other patient, one of the implants was a 3.25-mm-diameter implant replacing a lateral incisor (Table 2). Abutment placement was performed after 5 to 16 months. The prosthetic restorations were inserted 3 to 12 months later[5] (Table 2). Sixteen of the 18 patients were treated by the same prosthodontist. The 2 remaining patients with one implant each were treated by two different prosthodontists. All patients had natural teeth in the opposing arch and all had overjet/overbite within the normal range except 1 who had an anterior edge-to-edge occlusion. Two crowns were screw-retained, whereas all remaining prostheses were cemented on custom gold abutments. All crowns were single with the exception of three splinted crowns in 1 patient. Care was taken to leave all final implant-supported prostheses out of tight occlusal contacts in centric occlusion and lateral excursions.

At recall, 15 to 17 years after the initial surgery, the patients were examined clinically (evaluation of dental papilla, gingival/mucosal bleeding, and pocket depth) and radiologically (digital intraoral periapical radiographs) by one of the authors (KM). Patients' general satisfaction with speech and function and their overall satisfaction with the implant treatment in the esthetic zone were recorded using a specific questionnaire (not shown) and a modified visual analog scale (VAS) (Table 3). The patients were asked to state their satisfaction with speech and function

Table 1 Patient Demographics

Patient no.	Year of birth	Sex	Age at implant placement (y)	Smoking habit
1	1974	M	19	N
2	1964	F	29	N
3	1963	F	30	N
4	1973	M	19	N
5	1960	M	33	N
6	1975	F	18	N
7	1975	F	18	N
8	1974	M	19	N
9	1968	M	26	N
10	1967	F	27	N
11	1967	M	27	N
12	1970	M	24	Y*
13	1977	F	17	N
14	1954	M	41	N
15	1973	M	21	N
16	1974	M	21	N
17	1977	F	17	N†
18	1978	M	17	N

*Patient currently smokes 10 to 15 unfiltered cigarettes per day.
†The patient smoked filtered cigarettes from age 18 to 26.

Table 2 Implant Characteristics, Observation Times, and Peri-implant Bone Loss

Patient no.	Implant site‡	Implant diameter (mm)	Implant length (mm)	Date of placement (mo/y)	Date of abutment (mo/y)	Date of prosthetics (mo/y)	Recall date (mo/y)	Observation time (y)	M–D bone loss (mm)
1	21	3.75	15	09/1993	04/1994	09/1994	11/2009	15.2	1.1–1.7
2	21	3.75	15	10/1993	03/1994	08/1994	06/2009	14.10	1.5–1.4
3	11	3.75	13	10/1993	05/1994	12/1994	06/2009	14.6	0.8–0.5
4	21	3.75	10	01/1993	05/1994	01/1996	03/2010	*	*
	22	3.25	13	01/1993	05/1994	01/1996	03/2010	14.2	2.9–2.7
	23	3.75	15	01/1993	05/1994	01/1996	03/2010	14.2	1.8–1.9
5	21	3.75	13	11/1993	06/1994	03/1995	06/2009	14.3	1.2–1.3
6	21	3.75	13	12/1993	05/1994	08/1994	01/2010	15.5	1.0–1.1
7	21	3.75	15	01/1994	05/1994	11/1994	11/2009	15.0	1.4–1.6
8	11	3.75	13	01/1994	06/1994	03/1995	06/2009	14.3	1.8–1.5
9	11	3.75	13	09/1994	05/1995	05/1996	06/2009	13.1	0.8–0.7
10	21	3.75	15	10/1994	05/1995	05/1996	06/2009	13.1	1.8–1.9
11	21	3.75	15	04/1994	06/1995	10/1995	11/2009	14.1	1.0–0.9
12	11	3.75	15	12/1994	05/1995	03/1996	06/2009	13.3	5.1–1.7
13	21	3.75	15	01/1995	06/1995	06/1996	02/2010	13.8	0.7–0.8
14	11	3.75	15	02/1995	10/1995	02/1996	06/2009	13.4	0.8–0.7
15†	11	3.75	15	09/1995	04/1996	09/1996	06/2009	12.9	2.1–1.7
	21	3.75	15	09/1995	04/1996	09/1996	06/2009	12.9	2.2–2.2
	22	3.25	15	09/1995	04/1996	09/1996	06/2009	12.9	3.1–2.3
16	11	3.75	13	09/1995	06/1996	05/1997	06/2009	12.1	1.9–0.9
17	21	3.75	13	11/1995	02/1997	02/1997	06/2009	12.4	1.5–1.4
18	12	3.75	15	12/1995	11/1996	03/1997	06/2009	12.3	0.3–0.5

M–D = mesial to distal.
*Implant fracture after 10 years.
†The three crowns were splinted.
‡FDI tooth-numbering system.

Table 3 Patient Satisfaction with Implants*

Patient no.	Overall satisfaction	Esthetics	Speech	Function
1	10	9	10	10
2	8	8	10	10
3	10	9	10	10
4	9	10	10	10
5	8	8	10	10
6	10	10	10	10
7	10	10	10	10
8	9	9	10	10
9	10	10	10	10
10	9	8	8	10
11	9	9	10	10
12	7	6	10	8
13	10	8	10	10
14	10	10	10	10
15	10	9	10	10
16	6	8	10	10
17	8	7	10	10
18	10	10	10	10
Mean	9	8.8	9.9	9.9

*Modified visual analog scale, 0 (worst) to 10 (best).

Table 4 Professional Evaluation of Implants in the Anterior Maxilla

Patient no.	Implant site*	PIS mesial	PIS distal	AS	AP	State of prosthesis
1	21	2	1	5	7	O
2	21	1	1	8	8	O
3	11	1	2	5	4	N‡
4	21	†	†	†	†	–
	22	2	2	4	5	N
	23	2	2	4	5	N
5	21	1	1	5	3	O
6	21	3	3	8	8	O
7	21	3	3	8	8	N
8	11	3	2	3	6	R
9	11	1	2	5	7	O
10	21	2	1	7	8	N§
11	21	3	3	8	8	N
12	11	2	2	8	3	O
13	21	3	3	5	8	O
14	11	3	2	7	7	O
15	11	2	3	3	4	O‖
	21	2	2	3	4	O
	22	2	3	3	4	O
16	11	3	2	5	8	O‖
17	21	2	2	8	6	O
18	12	2	2	8	7	O‖
Mean VAS score				5.7	6.1	

PIS = Papillae Index Score according to Jemt et al[6]; AS = soft tissue esthetic evaluation using modified visual analog scale; AP = esthetic evaluation of prosthesis using modified visual analog scale (VAS). O = original; N = new .
*FDI tooth-numbering system.
†Implant loss.
‡New crown due to shade correction when another implant (21) was placed (1997).
§New crown when receiving one additional implant replacing 11 and a cantilever pontic replacing 22 (2004).
‖Minor porcelain fracture without required repair.

as well as their overall satisfaction ranging from 0 (not satisfied at all) to 10 (fully satisfied) expressed as whole numbers. Likewise, a modified VAS (0 to 10) and the Papilla Index Score (PIS)[6] were used for professional assessment of the esthetic outcome regarding both prosthetics and soft tissue at the implant site (Table 4).

Marginal bone levels were measured on digital periapical radiographs. Baseline radiographs were taken at abutment surgery and at loading with polyether impression material (3M ESPE) on an Eggen film holder for standardization through the first follow-up years. These imprinted holders were eventually discarded due to deterioration. However, follow-up radiographs were also taken using an Eggen film holder carefully keeping the radiograph parallel to the vertical axis of the implant and in the same angle as the original radiographs. To detect possible bone loss, the length of the implant was secured and used for calibration (Sectra IDS5 web version), and bone loss was measured as the distance between the lower edge of the neck of the implant as the defined reference point and the coronal bone level on the mesial and distal aspects of the implant.

Results

Of the 22 implants followed up for 15 to 17 years after initial surgery, 1 implant was lost due to implant fracture after 10 years. All other implants were clinically stable at recall. Marginal bone loss ranged from 0.3 to 5.1 mm, and mean marginal bone loss was 1.53 mm

Fig 1 Patient no. 5, a 50-year-old man with a 3.75 × 13-mm implant replacing the maxillary left central incisor (14-year observation time). The original crown shows pronounced incisal discrepancy compared with the natural teeth.

(standard error [SE] ± 0.17 mm, Table 2). The most advanced bone loss was seen in a smoker. Gingival/mucosal bleeding upon superficial probing was seen around 11 implants in 10 patients, and pocket depths ranged from 1 to 6 mm. Pockets were 2 to 6 mm at bleeding sites and 1 to 3 mm at nonbleeding sites, and three of the patients with bleeding on probing had easily detectable amounts of plaque. Six prosthetic restorations in five patients had been replaced and one prosthesis in one patient was repaired due to porcelain fractures or shade corrections. The original crowns were still present in the remaining patients, but some of these crowns had minor unrepaired porcelain fractures.

The patients' long-term overall satisfaction and evaluation of esthetics, speech, and function are given in Table 3. The professional assessment of esthetics is presented in Table 4. One original implant-supported crown showed an incisal discrepancy of more than 1.5 mm (Fig 1), while other crowns showed no or only slight vertical steps. Because of the lack of access to original clinical photographs, exact measures for vertical step development could not be provided. One patient (no. 12) had peri-implantitis (bleeding on probing with bone loss > 4 to 5 mm) around one implant and was treated surgically. Another patient (no. 15) was also subjected to explorative surgery due to suspected bone loss as judged by the periapical radiograph, but exposed threads were not observed at surgery. He apparently was suffering from bruxism and his crown, which was screw-retained, had become loose on several occasions. Both patients had one implant each.

Two patients originally had three adjacent implants. One of these implants fractured after 10 years. It had been replaced by his private clinician through a cantilever pontic on a tooth-supported fixed partial denture. In addition, two other patients (nos. 3 and 10) had received one additional implant each replacing a central incisor, and a cantilever pontic replaced the left lateral incisor in patient no. 10. At recall, adjacent implants showed more bone loss than the mean for solitary implants (1.8 to 3.1 mm vs 1.5 mm), the only exception being patient no. 3. The professional esthetic assessment scores for adjacent implants were lower regarding both soft tissue and supraconstructions.

Discussion

Within the limitations of the study design, this long-term follow-up study adds to the sparse knowledge on long-term results in the esthetic zone. Implant survival in these healthy patients free from periodontal disease was high, and the rate of surgical complications was low, while prosthetic complication rates were higher. The patients were overall satisfied with their restorations, more so than the professionals. Most implant studies present rates of implant loss below 10%, varying from 1% to 18%.[1]

Implant survival in this study (95.5%) is quite similar to that reported by Zarb and Zarb[4] on implant treatment of anterior partial edentulism (92% implant survival).

The observed 12- to 15-year mean marginal bone loss of 1.5 mm is in line with results from a systematic review of long-term follow-up studies of dental implants, where the 10-year mean marginal bone loss was between 0.7 and 1.3 mm.[1] The study appears to support previous findings that both esthetics and bone loss regarding adjacent implants are challenging.[3]

Incisal discrepancy is believed to be related to implant insertion at an early age. Jemt et al[7] found women with long faces to be the most prone to infraposition of implants in the esthetic zone. However, in the present study, the most pronounced incisal discrepancy was seen in a man who was 33 years old at implant placement (Fig 1). This finding, indicating

that a growth-related infraposition may also be expected after age 30, is in agreement with Bernard et al,[8] clearly showing that vertical steps of dental implants in the anterior maxilla can be expected in both young persons and older adults.

Long-term studies are difficult to organize and conduct and often suffer from a lack of details, as does the present study. In the review by Tomasi et al,[1] papers were excluded if dropout exceeded 30% after 10 years. In the present retrospective study, 67% of the patients did participate at recall 15 to 17 years after the initial surgery. The authors chose to consider this an acceptable figure of participation for adequate evaluation of the results after such a long timespan. Unfortunately, there are no details regarding the state of the implants in the dropout patients.

Conclusions

Within the limitations of this report, it may be predicted that long-term implant survival will be high, at least in healthy patients free from periodontal disease, and that prosthetic complications such as implant infraposition and porcelain fractures may be unavoidable. Consequently, patients should be given thorough preoperative information regarding the possible long-term outcome of dental implants in the esthetic zone.

Acknowledgment

The authors reported no conflicts of interest regarding this study.

References

1. Tomasi C, Wennstrøm JL, Berglundh T. Longevity of teeth and implants: A systematic review. J Oral Rehabil 2008;35:23–32.
2. Noack N, Willer J, Hoffmann J. Long-term results after placement of dental implants: Longitudinal study of 1964 implants over 16 years. Int J Oral Maxillofac Implants 1999;14:748–755.
3. Belser UC, Schmid B, Higginbottom F, Buser D. Outcome analysis of implant restorations located in the anterior maxilla: A review of the recent literature. Int J Oral Maxillofac Implants 2004; 19(suppl):30–42.
4. Zarb JP, Zarb GA. Implant prosthodontic management of anterior partial edentulism: Long-term follow-up of a prospective study. J Can Dent Assoc 2002;68:92–96.
5. Andersen E, Saxegaard E, Knutsen BM, Haanæs HR. A prospective clinical study evaluating the safety and effectiveness of narrow-diameter threaded implants in the anterior region of the maxilla. Int J Oral Maxillofac Implants 2001;16:217–224.
6. Jemt T. Regeneration of gingival papillae after single-implant treatment. Int J Periodontics Restorative Dent 1997;17:326–333.
7. Jemt T, Ahlberg G, Henriksson K, Bondevik O. Tooth movements adjacent to single-implant restorations after more than 15 years of follow-up. Int J Prosthodont 2007;20:626–632.
8. Bernard JP, Schatz JP, Christou P, Belser U, Kiliaridis S. Long-term vertical changes of the anterior maxillary teeth adjacent to single implants in young and mature adults. A retrospective study. J Clin Periodontol 2004;31:1024–1028.

Literature Abstract

A retrospective comparison of implants in the pterygomaxillary region: Implant placement with two-stage, single-stage, and guided surgery protocols

This retrospective study compared the cumulative survival rates (CSRs) of pterygomaxillary implants placed with two-stage freehand, single-stage freehand, and single-stage guided surgical protocols. Charts of all patients with pterygomaxillary implants placed between September 1985 and July 2011 in a single private practice were reviewed and categorized according to the following inclusion criteria: *(1)* the two-stage freehand category had placement of cover screws on the pterygomaxillary implants during the first stage of surgery, *(2)* the single-stage freehand category had immediate connection of transmucosal abutments to the pertygomaxillary implants and attachment of the provisional all-acrylic resin screw-retained prosthesis, *(3)* the single-stage guided surgery category had completely edentulous patients, and included the use of a cone beam computed tomography scan and a stereolithic surgical template. Nine-hundred eighty-one patients (371 men, 610 women) with a mean age of 58 years (range: 14 to 90 years) were included in the study. The results showed: *(1)* CSR of all pterygomaxillary implants was 90.8% (1,460 of 1,608 osseointegrated), *(2)* CSR for two-stage freehand implants was 85.94% (709 of 825 osseointegrated), *(3)* CSR for single-stage freehand implants was 96.45% (624 of 647 osseointegrated), *(4)* CSR of single-stage guided implants was 93.38% (127 of 136 osseointegrated), *(5)* CSR of combined all single-stage implants (both freehand and guided protocols) was 95.91% (751 of 783 osseointegrated), *(6)* CSR of all single-stage implants was significantly higher than CSR two-stage implants ($P < .05$), *(7)* no significant difference was found between CSR of single-stage freehand and single-stage guided implants ($P > .05$). The authors concluded that single-stage pterygomaxillary implants are beneficial to both patient and clinician, and that guided surgical protocol for pterygomaxillary implants is a feasible option.

Balshi TJ, Wolfinger GJ, Slauch RW, Balshi SF. *Int J Oral Maxillofac Implants* 2013;28:184–189. **References:** 31. **Reprints:** Dr Stephen Balshi, PI Dental Center, 467 Pennsylvania Avenue, Sulte 201, Fort Washington, PA 19034, USA. **Email:** Balshi2@aol.com—*Simon Ng, Singapore*