Immediate and Delayed Restoration of Dental Implants in Periodontally Susceptible Patients: 1-Year Results

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Purpose: *Immediate restoration of dental implants in patients with a history of periodontal disease was examined. The influence of insertion torque and implant stability quotient (ISQ) on the survival rate was compared in immediately restored, nonrestored, and submerged implants.* ***Materials and Methods:*** *Patients received periodontal treatment after which "all in one" implant surgery was performed: hopeless teeth were extracted, debridement around remaining adjacent teeth was performed, implants were inserted and, in some cases, a prefabricated screw-retained provisional restoration was immediately delivered. Insertion torque and ISQ were recorded at baseline and 6 and 12 months postsurgery.* ***Results:*** *Nineteen patients were treated, and 74 implants were placed. Twelve implants, 10 of which were maxillary, failed in 4 patients. Survival rates were 100% in partial-arch restorations, 94% in the mandible, and 78% in the maxilla. The survival rate of restored implants was 65% in extraction sites versus 94% in healed, nonextraction sites. Implants exhibited a decrease in ISQ at 6 months followed by an increase at 12 months. There were no statistically significant differences in insertion torque or ISQ between failed and successful implants, restored and nonrestored implants, or extraction-site and nonextraction-site implants. Mandibular implants demonstrated higher insertion torque and higher ISQ at baseline and 6 and 12 months.* ***Conclusions:*** *Within the limits of this study, immediate restoration of dental implants in periodontally susceptible patients had a variable success rate. Several factors were shown to affect these results.* (Comparative Cohort) Int J Oral Maxillofac Implants 2007;22:423–429

Key words: *dental implants, immediate loading, periodontal disease*

Success in implant therapy has been well documented for more than 3 decades.[1] This treatment modality is used for restoring totally edentulous dental arches[2,3] as well as partial-arch[4–7] and single-tooth[8] edentulism. Implant therapy also serves as an acceptable treatment for periodontitis patients whose dentition has been compromised as a result of cumulative bone loss. In cases where tooth retention becomes either impossible or impractical for reasons of patient comfort and quality of life, teeth can be extracted and replaced by dental implants and prosthetic restorations. A recent review of the literature[9] revealed a positive relationship between implant survival rate/implant bone level and magnitude of periodontal bone loss. Hardt et al[10] reported a higher failure rate in patients who experienced periodontal loss of alveolar-bone support. There are, however, other reports demonstrating implant survival rates in periodontally compromised patients that are similar to those of healthy patients.[11]

Immediate restoration of dental implants has been gaining popularity in the last years; single and multiple immediate implant restorations in partially and fully edentulous patients have been reported in both jaws.[12–17] Survival and success rates in these publications seem to be similar to those of the traditional protocol of loading 3 to 6 months after implant placement. Immediate restoration of dental implants may have significant advantages, especially in restorations involving the esthetic zone. Although this zone may vary from individual to individual, it generally includes the maxillary and mandibular incisors, canines, and premolars. Restoration of missing teeth in this area is highly demanding, and it is in this region that immediate fixed restorations are of

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the greatest benefit. Obviously, patients with hopeless teeth due to periodontal disease would benefit from such a treatment modality, especially if those teeth could be extracted and immediate implants and immediate restorations provided. However, there is, as yet, little information available about the immediate restoration of implants in patients with a history of periodontitis. In particular, information about treatment protocols and short- and long-term survival and success rates is lacking. Therefore, the general aim of this study was to examine immediate restoration of dental implants in such patients. Specific aims were *(1)* to evaluate the influence of primary stability, as measured by insertion torque and resonance frequency analysis (RFA), on the survival and success of dental implants and *(2)* to compare those parameters in immediately restored and nonrestored implants.

MATERIALS AND METHODS

Patients attending the Unit of Periodontology at the Rambam Health Care Campus were offered the opportunity to participate in the study if they were between the ages of 18 and 75, had been diagnosed with chronic periodontitis based on clinical and radiographic assessments,[18] had no complicating systemic conditions that would contraindicate surgical periodontal and/or implant treatment (eg, pregnancy, uncontrolled diabetes), and required 1 or more of the following:

- Restoration of all maxillary or mandibular dentition
- A fixed partial implant-supported restoration in the esthetic zone
- A single-tooth implant-supported restoration in the esthetic zone

Patients received periodontal treatment, including oral hygiene instructions, scaling and root planning, and periodontal surgery as necessary. Casts, periapical and panoramic radiographs, and computerized tomographic (CT) scans were used for evaluation and prosthetic treatment planning. Treatment plan options were presented to the patient, and final eligibility was ascertained when patients expressed their preference for a fixed restoration. A surgical stent and a provisional fixed restoration were fabricated prior to commencement of the combined implant-prosthetic treatment. All provisional restorations were screw retained.

The study was carried out in accordance with the guidelines of the Helsinki Declaration. All patients signed a consent form.

"All in one" implant surgery was performed. Teeth with a hopeless prognosis (ie, those that had insufficient attachment for maintenance[19]) were extracted. Flap debridement around remaining adjacent teeth was performed as necessary, and implants (MIS Implant Technologies, Shlomi, Israel) were inserted, guided by the surgical stent. In cases of partial edentulism, 2 to 4 implants were selected as abutments for a provisional restoration; in cases of full edentulism, 3 to 4 implants were selected for this purpose. Clinical judgment was used in the selection of implants for immediate restoration. The implants with the highest implant stability quotient (ISQ) and the best positioning for adequate esthetics were selected to support the immediate provisional restoration. The restoration was prefabricated in the laboratory and adapted to those implants. Briefly, conical abutments were screwed in with 20 Ncm torque. Gold cylinders were connected to the conical abutments. Thereafter, the restoration was connected to the gold cylinders with acrylic resin and removed to be adapted and finished extraorally. Finally, the restoration was delivered to the patient, screwed into the conical abutments with 20 Ncm torque, and occlusally adjusted. Single implants were similarly restored with a screwed-in crown restoration fabricated from acrylic resin. Every effort was made to minimize implant movement during the healing period. To this end the following guidelines were followed:

1. Care was taken to achieve a passive fit to the implants.
2. No contact between the restoration and adjacent teeth was allowed.
3. Single- and partial-arch restorations were delivered with no occlusal contact between the restoration and the opposing arch in intercuspation or lateral or protrusive movements.
4. Full-arch restorations had a balanced occlusion.

The rest of the implants either received a healing abutment and were left to heal as nonsubmerged 1-stage implants or received a cover screw and were submerged for a period of 6 months.

Patients were prescribed postoperatively a 0.2% chlorhexidine mouthrinse, amoxicillin 500 mg TID for 7 days, and analgesic therapy as necessary.

Data collection included

- Implant length and diameter
- Type of implantation
  - Immediate implantation following extraction (extraction sites)
  - Delayed implantation in edentulous ridges

Table 1 Implant Distribution by Jaw

	Maxilla		Mandible		Total	
	No. of implants	No. of patients	No. of implants	No. of patients	No. of implants	No. of patients
Single-tooth	4	4	1	1	5	5
Partial-arch	21	7	13	5	34	10
Full-arch	21	3	14	2	35	5
Total	46	14	28	8	74	19

One patient had both a single-tooth implant and a full-arch restoration; therefore, the total number of patients was 19, not 20.

- Type of loading
  - Submerged (ie, the traditional method)
  - Nonsubmerged and not immediately restored
  - Nonsubmerged and immediately restored
- Insertion torque
- RFA, expressed as an ISQ (Osstell; Integration Diagnostics, Göteborg, Sweden)

Patients were examined 7 to 10 days after surgery for suture removal and then after 2 weeks, 4 weeks, 8 weeks, and 3 months. At 6 months the restoration was removed, interim implant success was evaluated, second-stage surgery was performed for the submerged implants, RFA was recorded, periapical radiographs were obtained, and patients were referred for definitive prosthetic restorations. Failed implants were removed, and additional implant surgery was provided as necessary to enable successful prosthetic restorations. Twelve months postsurgery, RFA was repeated, and periapical radiographs were again obtained.

Data Management and Analysis

Data analysis was performed 2 ways using a statistical software program (Statview 512+; BrainPower, Calabasas, CA). The Student *t* test for paired observations was utilized to assess the changes from baseline to 6 and 12 months for each parameter within the same treatment group. The Student *t* test for unpaired observations was used to compare the changes from baseline to 6 and 12 months between the 2 treatment groups. Student *t* test for unpaired observations and analysis of variance (ANOVA) were used to compare data between groups at different time points.

RESULTS

Nineteen patients completed the study, 17 women and 2 men, who ranged in age between 34 and 79 years. Patients were generally diagnosed with moderate to severe generalized chronic periodontitis, evidenced by their extensive bone loss. Orthopantomographs and periapical radiographs were used to measure radiographic root length and remaining alveolar bone height. The ratio between alveolar bone height and root length was calculated to represent the percentage of remaining alveolar bone support. Mean remaining bone support was 52% (range, 31% to 76%).

Table 2 Survival Rates

Variable	No. of implants	No. of failures	Survival rate (%)
Type of restoration			
Full-arch			
Maxilla	21	10	52
Mandible	14	1	93
Partial arch	34	0	100
Single tooth	5	1	80
Position			
Anterior	34	4	88
Posterior	40	8	80
Implant length			
10 mm	7	1	86
11.5 mm	15	2	87
13 mm	46	6	87
16 mm	6	3	50
Implant width			
3.3 mm	7	2	72
3.75 mm	48	4	91.5
4.2 mm	19	6	69
Total	74	12	84

The study sample included 3 cases of maxillary full-arch edentulism, 2 cases of mandibular full-arch edentulism, 7 cases of maxillary partial-arch edentulism, 5 cases of mandibular partial-arch edentulism, and 5 single-tooth replacements (1 mandibular and 4 maxillary; Table 1). Forty-eight implants were 3.75 mm in diameter (65%), 19 were 4.2 mm (25.5%), and 7 were 3.3 mm in diameter (9.5%). Forty-one implants were placed immediately after tooth extraction; of those, 26 were immediately restored. The rest (n = 33) were inserted in edentulous ridges. A total of 74 implants were inserted.

Twelve implants in 4 patients failed, resulting in a total implant survival rate of 84%. Ten of the failed implants were in maxillary sites, and 8 were in posterior regions. The survival rate was 78% (34 of 44) in the maxilla and 94% (28 of 30) in the mandible (Table 2).

Table 3 Insertion Torque and ISQ Levels by Restoration Type

	Immediate (n = 42)		Submerged (n = 23)		Nonrestored (n = 9)		
Variable	Mean	SE	Mean	SE	Mean	SE	*P*
Insertion torque (Ncm)	39.33	1.27	36.00	1.61	40.00	3.23	.2765
ISQ							
Insertion	64.07	1.90	57.95	2.36	67.22	1.89	.0625
6 mo	62.94	0.97*	56.05	2.19*†	59.33	5.87	.0461
12 mo	67.28	1.12*	61.11	1.69*†	71.11	1.93†	.0005§
Δ from insertion to 6 mo	−3.10	2.10	−2.10	2.90	−7.90	6.00	.5277
Δ from insertion to 12 mo	1.81	2.50	5.20	2.10	3.89	2.50	.5975

Immediate = immediately restored; Nonrestored = nonsubmerged, nonrestored.
*,†Differences between groups significant at 95% (ANOVA).
†n = 21.
§For both immediate versus submerged and submerged versus nonrestored.

Table 4 Insertion Torque and ISQ Levels: Extraction Sites Versus Nonextraction Sites

	Nonextraction (n = 33)		Extraction (n = 41)		
Variable	Mean	SE	Mean	SE	*P*
Insertion torque (Ncm)	38.7	1.6	38.3	1.2	.8362
ISQ					
Insertion	63.8	2.2	61.8	1.7	.4750
6 mo	59.7	2	60.3	1.7	.8195
12 mo	66.1	1.6	65.7	1.3	.8382
Δ from insertion to 6 mo	−4.72	2.63	−2.29	2.13	.4726
Δ from insertion to 12 mo	1.68	2.53	4.15	1.95	.4450

All failures occurred within the first 6 months. Failed implants were removed during the 6-month examination at second-stage surgery/prosthesis removal and evaluation. Eventually all failed implants were replaced with additional implants that were used to support the definitive fixed restorations. No failures occurred between 6 and 12 months postsurgery.

Insertion torque and ISQ levels in the immediate, submerged, and nonrestored groups are reported in Table 3. The differences in insertion torque among the 3 groups were not statistically significant (P = .2765). ISQ level at baseline was higher in the immediate group relative to the submerged group (64.07 ± 1.90 vs 57.95 ± 2.36, P = .0625). ISQ was similarly higher at 6 months (62.94 ± 0.97 vs 56.05 ± 2.19, P = .0461). At 12 months there were significant differences (P = .0005) between the immediate and submerged groups (67.28 ± 1.12 vs 61.11 ± 1.69) and between the submerged and nonrestored groups (61.11 ± 1.69 vs 71.11 ± 1.93). There was no statistically significant difference in ISQ change between baseline and 6 months and between baseline and 12 months. All groups exhibited a decrease in ISQ at 6 months followed by an increase at 12 months.

Data were also stratified between nonextraction and extraction sites (Table 4). Insertion torque was similar in both groups (38.7 ± 1.6 and 38.3 ± 1.2 respectively, P = .8362). Likewise, there was no difference between ISQ values for the 2 groups at baseline, 6, or 12 months. There was no significant difference between the 2 groups with respect to change in ISQ from baseline to 6 or 12 months.

When comparing maxillary and mandibular implants (Table 5), statistically significant differences were found with respect to insertion torque (36.44 ± 1.17 vs 41.60 ± 1.5, P = .0085) and ISQ at 12 months (64.06 ± 1.08 vs 70.23 ± 1.46, P = .001). The differences in insertion ISQ and ISQ at 6 months were marginally significant (P = .0601).

Insertion torque and ISQ for failed and successful implants were compared. There were no statistically significant differences between these 2 groups.

Survival rates are reported for different implant categories in Table 6. Immediately restored implants

Table 5 Insertion Torque and ISQ Levels: Maxillary Versus Mandibular Implants

Variable	Maxilla (n = 46) Mean	Maxilla (n = 46) SE	Mandible (n = 28) Mean	Mandible (n = 28) SE	*P*
Insertion torque (Ncm)	36.44	1.17	41.60	1.50	.0085
ISQ					
Insertion	60.64	1.64	65.89	2.29	.0601
6 mo	57.97	1.42	62.81	2.23	.0601
12 mo	64.06	1.08	70.23	1.46	.0010
Δ from insertion to 6 mo	−3.50	1.75	−0.17	2.49	.2634
Δ from insertion to 12 mo	2.38	1.83	5.17	2.71	.3802

Table 6 Survival Rates of Implants According to Restoration Categories in Extraction and Nonextraction Sites

Variable	No. of implants	No. of failures	Survival rate (%)
Immediate			
Nonextraction	16	1	94
Extraction	26	9	65
Submerged			
Nonextraction	9	0	100
Extraction	14	2	86
Nonrestored			
Nonextraction	8	0	100
Extraction	1	0	100

in extraction sites had a 65% survival rate, whereas those in healed (nonextraction) sites exhibited a 94% survival rate. Submerged implants placed in extraction sites had an 86% survival rate, while those in nonextraction sites had a 100% survival rate.

DISCUSSION

A history of periodontal disease may increase implant failure rates. In a retrospective study Hardt et al[10] examined 97 partially dentate patients who received 346 implants in the posterior maxilla and found a 92% survival rate for patients with a history of periodontal disease versus 96.7% for "nonperiodontal" patients. Likewise, Evian et al,[20] in a retrospective analysis of 149 patients, found a 79% survival rate in periodontal patients versus 92% in nonperiodontal patients. Survival rates reported immediately restored implants range from 80%[21] to 100%.[22,23] Prior to treatment the patient group in the present study had mean radiographic alveolar bone support around their teeth of 52% (range, 31% to 76%), indicating the severity of their periodontal disease and, therefore, periodontal susceptibility. Overall implant survival rate in the present study was 84%, which corroborates Evian et al[20] and may reflect the influence of periodontal susceptibility on implant survival rate. Also, 10 of the 12 implant failures in the presented study occurred in 2 patients. This clustering phenomenon has been previously described.[24–26]

The overall mandibular survival rate was 94%; this is similar to many reports of immediate full-arch mandibular loading.[14,27,28] In contrast, the survival rate of maxillary implants was 78%, lower than the 87.5% to 100% of most reports.[29,30] Ten of 12 failed implants were in the maxilla, a disproportionately high figure. This may be attributed to the low density and thin cortical plates,[31] which might have influenced the resistance to mechanical stresses.

Micromotion of implants plays a crucial role in their survival and success.[14,32,33] Prostheses were fabricated with gold-plastic abutment cylinders rather than temporary titanium cylinders connecting the

restoration to the anatomic abutments. The metallic part of this cylinder is shorter than that of a temporary titanium cylinder. These abutments may have reduced the rigidity of the prostheses and increased implant micromotion, which may have decreased the implant survival rate.

A marked difference was found in survival rates of immediately restored implants placed in healed (nonextraction) sites compared to those placed in extraction sites (94% vs 65%). In contrast, similar survival rates have previously been reported for healed and extraction sites.[34,35] In the present study, the survival rate was lower in submerged extraction sites than in submerged nonextraction sites as well, which further implicates placement in an extraction site as a risk factor for implant failure. However, stratification between extraction and nonextraction sites revealed no statistically significant difference between the groups in either insertion torque, insertion ISQ, or change in ISQ from insertion to 12 months. Based on these data, primary stability in the present study did not contribute to implant failure in extraction sites.

Insertion torque and ISQ have rarely been reported in correlation with implant survival.[36–38] Ottoni et al[36] reported failure of 9 of 10 immediately loaded implants inserted with a torque of 20 Ncm. However, in the present study, insertion torque of immediately restored failed implants ranged from 30 to 50 Ncm. Average insertion torque was 38 Ncm, which is comparable with the results of da Cunha et al,[39] who reported insertion torques of 33.4 and 40.81 Ncm for TiUnite and standard machined implants, respectively. The average insertion ISQ of immediately restored implants was 64.07 (range, 46 to 81). This is comparable with Olsson et al,[40] who reported a mean primary ISQ of 60.1 for maxillary implants in fully edentulous patients. Sennerby and Meredith[41] suggested that implants with a primary stability greater than ISQ 60 to 65 may be suitable for immediate loading. In the present study failed implants had a mean ISQ of 57.46, slightly below the ISQ recommended by Sennerby and Meredith, but not statistically different from ISQ of successful implants. Eight of the 12 failed implants were restored due to prosthetic requirements, even though their ISQ was below 60. Although establishing a threshold ISQ may be valuable for clinical purposes, a minimal ISQ for immediate restoration could not be established within the limitations of the present study. Maxillary implants had a lower insertion torque, possibly related to lower maxillary bone density. However, there was only a marginal difference between maxillary and mandibular insertion ISQ. The difference became statistically significant at 12 months, further indicating a possible difference in implant stability between the 2 jaws.

Differences in various parameters between immediately restored, nonrestored, and submerged implants should be interpreted with caution due to nonrandomized distribution between groups. Insertion torque was indeed slightly lower for the submerged group, the difference being statistically insignificant. There was a marginally significant difference ($P = .0625$) in insertion ISQ between the restored and submerged groups. Interestingly, the difference reached statistical significance at 6 and 12 months. Submerged implants were not loaded in the first 6 months postsurgery. Therefore, the 12-month data represent approximately 6 months of loading for those implants. Indeed, the 6-month ISQs of the immediately restored implants were similar to the 12-month ISQs of the submerged implants. The trend in all implant groups was of a decrease between baseline and 6 months and then an increase from 6 to 12 months to values exceeding baseline values. This is in contrast to a report by Bischof et al,[42] who reported an increase in ISQ from baseline to 12 weeks postsurgery.

In conclusion, within the limits of this study, a variable success rate was demonstrated for immediate restoration of dental implants in periodontally susceptible patients. Several factors have been shown to affect these results.

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REFERENCES

1. Albrektsson T, Zarb G, Worthington P, Eriksson AR. The long-term efficacy of currently used dental implants: A review and proposed criteria of success. Int J Oral Maxillofac Implants 1986;1:11–25.
2. Adell R, Eriksson B, Lekholm U, Brånemark P-I, Jemt T. A long-term follow-up study of osseointegrated implants in the treatment of the totally edentulous jaw. Int J Oral Maxillofac Implants 1990;5:347–359.
3. Lindquist LW, Carlsson GE, Jemt T. A prospective 15-year follow-up study of mandibular fixed prostheses supported by osseointegrated implants. Clinical results and marginal bone loss. Clin Oral Implants Res 1996;7:329–336.
4. Jemt T, Lekholm U, Adell R. Osseointegrated implants in the treatment of partially edentulous patients. A preliminary study on 876 consecutively placed fixtures. Int J Oral Maxillofac Implants 1989;4:211–217.
5. van Steenberghe D, Sullivan D, Liström R, et al. A retrospective multicenter evaluation of the survival rate of osseointegrated fixtures and supported bridges in the treatment of partial edentulism. J Prosthet Dent 1989;61:217–223.

6. van Steenberghe D, Lekholm U, Bolender C, et al. The applicability of osseointegrated oral implants in the rehabilitation of partial edentulism: A prospective multicenter study on 558 fixtures. Int J Oral Maxillofac Implants 1990;5:272–281.
7. Naert I, Quirynen M, van Steenberghe D, Darius P. A six-year prosthodontic study of 509 consecutively inserted implants for the treatment of partial edentulism. J Prosthet Dent 1992;67:236–245.
8. Sadan A, Blatz MB, Salinas TJ, Block MS. Single-implant restorations: A contemporary approach for achieving a predictable outcome. J Oral Maxillofac Surg 2004;62(9 suppl 2):73–81.
9. Van der Weijden G, Van Bemmen KM, Renvert S. Implant therapy in partially edentulous, periodontally compromised patients: A review. J Clin Periodontol 2005;32:506–511.
10. Hardt CR, Grondahl K, Lekholm U, Wennstrom JL. Outcome of implant therapy in relation to experienced loss of periodontal bone support: A retrospective 5-year study. Clin Oral Implants Res 2002;13:488–494.
11. Baelum V, Ellegaard B. Implant survival in periodontally compromised patients. J Periodontol 2004;75:1404–1412.
12. Tarnow DP, Emtiaz S, Classi A. Immediate loading of threaded implants at stage 1 surgery in edentulous arches: Ten consecutive case reports with 1- to 5-year data. Int J Oral Maxillofac Implants 1997;12:319–324.
13. Jaffin RA, Kumar A, Berman CL. Immediate loading of implants in partially and fully edentulous jaws: A series of 27 case reports. J Periodontol 2000;71:833–838.
14. Gapski R, Wang HL, Mascarenhas P, Lang NP. Critical review of immediate implant loading. Clin Oral Implants Res 2003;14:515–527.
15. Nikellis I, Levi A, Nicolopoulos C. Immediate loading of 190 endosseous dental implants: A prospective observational study of 40 patient treatments with up to 2-year data. Int J Oral Maxillofac Implants 2004;19:116–123.
16. Drago CJ, Lazzara RJ. Immediate provisional restoration of Osseotite implants: A clinical report of 18-month results. Int J Oral Maxillofac Implants 2004;19:534–541.
17. Jaffin RA, Kumar A, Berman CL. Immediate loading of dental implants in the completely edentulous maxilla: A clinical report. Int J Oral Maxillofac Implants 2004;19:721–730.
18. Flemmig TF. Periodontitis. Ann Periodontol 1999;4:32–38.
19. McGuire MK, Nunn ME. Prognosis versus actual outcome. II. The effectiveness of clinical parameters in developing an accurate prognosis. J Periodontol 1996;67:658–665.
20. Evian CI, Emling R, Rosenberg ES, et al. Retrospective analysis of implant survival and the influence of periodontal disease and immediate placement on long-term results. Int J Oral Maxillofac Implants 2004;19:393–398.
21. Balshi TJ, Wolfinger GJ. Immediate loading of Brånemark implants in edentulous mandibles: A preliminary report. Implant Dent 1997;6:83–88.
22. Misch CE, Degidi M. Five-year prospective study of immediate/early loading of fixed prostheses in completely edentulous jaws with a bone quality-based implant system. Clin Implant Dent Relat Res 2003;5:17–28.
23. Glauser R, Lundgren AK, Gottlow J, et al. Immediate occlusal loading of Brånemark TiUnite implants placed predominantly in soft bone: 1-year results of a prospective clinical study. Clin Implant Dent Relat Res 2003;5(suppl 1):47–55.
24. Hutton JE, Heath MR, Chai JY, et al. Factors related to success and failure rates at 3-year follow-up in a multicenter study of overdentures supported by Brånemark implants. Int J Oral Maxillofac Implants 1995;10:33–42.
25. Ekfeldt A, Christiansson U, Eriksson T, et al. A retrospective analysis of factors associated with multiple implant failures in maxillae. Clin Oral Implants Res 2001;12:462–467.
26. Chuang SK, Cai T, Douglass CW, Wei LJ, Dodson TB. Frailty approach for the analysis of clustered failure time observations in dental research. J Dent Res 2005;84:54–58.
27. Chiapasco M. Early and immediate restoration and loading of implants in completely edentulous patients. Int J Oral Maxillofac Implants 2004;19(suppl):76–91.
28. Ganeles J, Wismeijer D. Early and immediately restored and loaded dental implants for single-tooth and partial-arch applications. Int J Oral Maxillofac Implants 2004;19(suppl):92–102.
29. Grunder U. Immediate functional loading of immediate implants placed in edentulous arches: 2-year results. Int J Periodontics Restorative Dent 2001;21:545–551.
30. Misch CE, Degidi M. Five-year prospective study of immediate/early loading of fixed prostheses in completely edentulous jaws with a bone quality-based implant system. Clin Implant Dent Relat Res 2003;5:18–28.
31. Kourtis SG, Sotiriadou S, Voliotis S, Challas A. Private practice results of dental implants. Part I: Survival and evaluation of risk factors—Part II: Surgical and prosthetic complications. Implant Dent 2004;13:373–385.
32. Cameron H, Pilliar RM, Macnab I. The effect of movement on the bonding of porous metal to bone. J Biomed Mater Res 1973;7:301–311.
33. Szmukler-Moncler S, Salama H, Reingewirtz Y, Dubruille JH. Timing of loading and effect of micromotion on bone dental implant interface: Review of experimental literature. J Biomed Mater Res 1998;43:192–203.
34. Jaffin RA, Kumar A, Berman CL. Immediate loading of dental implants in the completely edentulous maxilla: A clinical report. Int J Oral Maxillofac Implants 2004;19:721–730.
35. Nordin T, Nilsson R, Frykholm A, Hallman M. A 3-arm study of early loading of rough-surfaced implants in the completely edentulous maxilla and in the edentulous posterior maxilla and mandible: Results after 1 year of loading. Int J Oral Maxillofac Implants 2004;19:880–886.
36. Ottoni JM, Oliveira ZF, Mansini R, Cabral AM. Correlation between placement torque and survival of single-tooth implants. Int J Oral Maxillofac Implants 2005;20:769–776.
37. Becker W, Becker BE, Huffstetlert S. Early functional loading at 5 days for Brånemark implants placed into edentulous mandibles: A prospective, open-ended, longitudinal study. J Periodontol 2003;74:695–702.
38. Malo P, Friberg B, Polizzi G, Gualini F, Vighagen T, Rangert B. Immediate and early function of Brånemark System implants placed in the esthetic zone: A 1-year prospective clinical multicenter study. Clin Implant Dent Relat Res 2003;5(suppl 1):37–46.
39. da Cunha HA, Francischone CE, Nary HF, de Oliveira RCG. A comparison between cutting torque and resonance frequency in the assessment of primary stability and final torque capacity of standard and TiUnite single-tooth implants under immediate loading. Int J Oral Maxillofac Implants 2004;19:578–585.
40. Olsson M, Urde G, Andersen JB, Sennerby L. Early loading of maxillary fixed cross-arch dental prostheses supported by six or eight oxidized titanium implants: Results after 1 year of loading, case series. Clin Implant Dent Relat Res 2003;5 Suppl 1:81–87.
41. Sennerby L, Meredith N. Analisi della frequenza di resonanza (RFA). Conoscenze attuali e implicazioni cliniche. In: Chiapasco M, Gatti C (eds). Osteointegrazione e Carico Immediato. Fondamenti Biologici e Applicazioni Cliniche. Milan: Masson.
42. Bischof M, Nedir R, Szmukler-Moncler S, Bernard JP, Samson J. Implant stability measurement of delayed and immediately loaded implants during healing. Clin Oral Implants Res 2004;15:529–539.