A 4-Year Evaluation of the Peri-Implant Parameters of Immediately Loaded Implants Placed in Fresh Extraction Sockets

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Background: The present study considers the correlation between the meaning of keratinized mucosa (KM) and the long-term maintenance of endosseous root-form dental implants placed in fresh sockets and immediately loaded.

Methods: Twenty-nine patients requiring extractions of ≥2 teeth in the maxilla and mandible were selected. One-hundred thirty-two maxillary and 32 mandibular teeth, in the incisor, canine, and premolar regions, were extracted. Implants were positioned in fresh sockets and immediately loaded. Based on the amounts of KM, implants were categorized as follows: KM ≥2 mm (group A) and KM <2 mm (group B). Clinical parameters (probing depth, modified plaque index, modified bleeding index, and gingival index) and marginal bone levels were followed at 4 years after implant placement. Comparisons between group A and B values were performed by the Student two-tailed *t* test.

Results: At 4-year follow-up, a survival rate of 100% was reported for all implants. The mean values of group B were significantly higher (P <0.05) than group A for the following parameters: gingival index (group A, 0.67 ± 0.09; group B, 1.01 ± 0.11); modified plaque index (group A, 1.18 ± 0.09; group B, 1.71 ± 0.12); and modified bleeding index (group A, 0.35 ± 0.05; group B, 0.78 ± 0.05). Gingival recession was significantly elevated in group B. In both group A and group B, up to 60% of gingival recession occurred within the first 6 months. For mean bone loss values, statistically nonsignificant differences were reported between groups.

Conclusions: At 4-year follow-up, the results suggested that the presence of mid-buccal KM is not a critical factor in the maintenance of interproximal bone level around fresh socket implants immediately loaded. Conversely, less width of KM is significantly associated with more gingival inflammation, more plaque accumulation, and more gingival recession. *J Periodontol 2010;81:1629-1634.*

KEY WORDS

Dental implants; oral mucosa; peri-implant.

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As with the assessment of bone preservation, soft tissue management around implants represents an important esthetic concern for patients. To avoid alveolar bone collapse and to maintain an excellent esthetic profile of the soft tissues around an implant-prosthetic restoration, different authors[1-3] placed dental implants with immediate loading in fresh extraction sockets (occlusal load applied to temporary crowns positioned immediately on implants) from premolar to premolar regions, reporting a survival rate of 100%, with minimal bone crestal loss.

An adequately keratinized zone of masticatory mucosa is mandatory for gingival preservation in fresh socket implant treatment; there was a significant association between subgingival restorations and gingival inflammation in areas with minimal keratinized gingiva in patients with poor plaque control.[1-5] It can be speculated that an inadequate amount of keratinized mucosa (KM), especially with non-optimal oral hygiene, negatively influences the long-term maintenance of marginal tissues of restored teeth or dental implants. In addition, inflammatory reactions of peri-implant tissues lead to progressive bone loss with a negative effect on the long-term prognosis of the implant procedure.[6-8]

Conversely, several studies[9-11] reported mucosal health without any keratinized

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gingiva, and the lack of attached gingiva did not damage the maintenance of soft tissue health around dental implants.[12]

Chung et al.[13] investigated the significance of KM in the maintenance of root-form dental implants with different surfaces. The authors concluded that the absence of adequate KM in endosseous dental implants, especially in posterior implants, was associated with higher plaque accumulation and gingival inflammation but not with more bone loss, regardless of their surface configurations.

Other critical requirements for final implant esthetics include the peri-implant soft tissue setting, gingiva level, color, and texture.[14-16] The accurate evaluation of bone and soft tissues around extraction sockets represent a main concern before immediate implant placement.[17]

Because there is a limited number of studies[12-14] investigating the relationship between keratinized tissue and peri-implant health in fresh socket implants, the aim of the present study is to consider the correlation between the meaning of KM and the long-term maintenance of endosseous root-form dental implants, placed and loaded immediately after tooth extractions.

MATERIALS AND METHODS

Patient Selection

From December 2004 to February 2005, 29 patients (11 females and 18 males, age range 25 to 67 years; mean age: 49.52 years) were included in this study. All selected patients required extractions of ≥2 teeth in the maxilla and mandible for root fractures, caries, endodontic lesions, or periodontal disease. Implants were positioned and loaded immediately after tooth extraction. The patients included in this clinical study were treated by one oral surgeon (RC) and one prosthetic specialist (EG) in the Department of Dentistry, San Raffaele Hospital, Milan, Italy.

Inclusion criteria. 1) patient was in good health, 2) no chronic systemic disease, 3) four bony walls of the alveolus were present, and 4) ≥4 mm of bone beyond the root apex was present.

Exclusion criteria. 1) presence of dehiscence or fenestration of the residual bony walls, 2) presence of coagulation disorders, 3) presence of signs of acute infection around alveolar bone at the surgical site, 4) heavy smoker (>10 cigarettes per day), 5) alcohol or drug abuse, and 6) bruxism.

The study protocol was approved by the Vita Salute University Institutional Review Committee, Milan, Italy for human subjects and all patients signed a written informed consent form for immediate implant loading. The study was conducted in accordance with the Helsinki Declaration of 1975, as revised in 2000.

Surgical Protocol

One hour before surgery, patients received 1 g amoxicillin and 1 g amoxicillin twice a day for 7 days after the surgical procedure. Surgery was performed under local anesthesia (optocaine,† 20 mg/ml, with adrenaline 1:80.000).

One-hundred thirty-two maxillary and 32 mandibular teeth in the incisor, canine, and premolar regions were extracted maintaining the integrity of the socket, avoiding buccal and palatal flaps. A periodontal probe‡ was used to verify the integrity of the four walls of the fresh sockets (Table 1). All experimental sites showed the absence of fenestration of dehiscence, and no regenerative procedures were performed in any of the sites.

The implant site was prepared with standard drills following the palatal bony walls as a guide, and the apical portion of the implant was always placed ≥4 mm beyond the root apex; no countersinking was used. The quality of alveolar bone was determined during surgery for each site and was predominantly classified as quality 2 and 3, according to the Lekholm and Zarb classification.[18]

Dental titanium implants had a machined neck for 0.8 mm, and a rough surface, titanium plasma spray, body with a progressive thread design§ with external hexagon as implant–abutment junctions. Seventy-two implants had a diameter of 5 mm, and 92 implants had a diameter of 3.80 mm with a 13-mm length, and were immediately loaded. The platform of the implants was inserted 1 mm below the level of the alveolar crest. Based on the amounts of KM, implants were categorized as follows: KM ≥2 mm (group A) and KM <2 mm (group B) (Table 1).

Immediately after the surgical procedure temporary abutments were placed and temporary crowns were cemented. Immediate loading of the implants was performed with implant insertion torque ≥35 Ncm. No flap was raised in all cases. Chlorhexidine mouthwash was prescribed twice daily for the next 15 days.

Prosthetic Protocol

Immediately after the surgical procedure, all patients received the temporary prosthetic reconstructions. Partially or total bridge fixed temporary reconstructions had a fiber-reinforced framework and accustomed with acrylic resin along the margins of the abutment and fit with temporary cement.‖ Distal cantilevers were avoided. All temporary crowns were in full contact in centric occlusion, making the occlusal surfaces flat, reducing horizontal relations. All patients followed a soft diet (avoiding bread and meat) for 2 months.

† Molteni Dental, Scandicci (FI), Italy.
‡ Hu-Friedy PGF-GFS, Hu-Friedy, Chicago, IL.
§ Seven, Sweden-Martina, Padova, Italy.
‖ Temp Bond, Kerr Manufacturing, Romulus, MI.

Table 1.

Number of Teeth/Implants for Groups A (n = 125) and B (n = 39)

	Group A	Group B
Maxilla		
Incisors	42	9
Canines	23	3
Premolars	49	6
Mandible		
Incisors	3	11
Canines	2	3
Premolars	6	7
Total	125	39

Group A = KM ≥2 mm; group B = KM <2 mm.

Follow-Up Evaluation

Follow-up visits were performed by a dental hygienist (Elisabetta Polizzi, Department of Dentistry, San Raffaele Hospital, Milan, Italy) twice a year for 4 years after implant insertion. The following clinical parameters were checked: 1) gingival index (GI)[19]; 2) modified plaque index[19]; 3) modified bleeding index (mBI) registered around four surfaces of implants[20]; and 4) probing depth measured at four points (mesio-buccal, mid-buccal, disto-buccal, and mid-lingual) to the nearest millimeter with a pressure-sensitive probe,[¶] using a standardized pressure of 0.35 N. The gingival recession was calculated as the distance between the soft tissue margin and the supragingivally located top of the abutment, measured to the nearest millimeter using the periodontal probe.[21] The width of KM at the mid-buccal point was measured from the mucogingival junction to the free gingival margin using a periodontal probe.[#] Baseline levels were measured at the time of placing the immediate prosthesis. All clinical assessments were performed by one examiner (EP), who before the start of the study was trained and calibrated with respect to the various assessments included in the study. Intraexaminer variation was evaluated by means of double assessments in 10 patients. The mean difference between pairs of linear assessments varied between 0.13 and 0.16 for the variables. In 83% to 89% of the sites the measurements were identical. No difference to >1 mm was recorded. Success criteria for implant survival were: 1) presence of implant stability; 2) absence of radiolucent zone around the implants; 3) no mucosal suppuration; and 4) no pain.

Radiographic Assessments

Intraoral digital radiographic examinations[**] were made at baseline, 12, 24, and 48 months after implant placement. The periapical radiographs were taken perpendicularly to the long axis of the implant with a long-cone parallel technique using an occlusal template to measure the marginal bone level. A radiologist (PC) measured twice the changes in marginal bone height over time. The reference points and measured lines were marked on the screen interactively (the numeric value of measurement was reported by the software[††]). Implant height (a known dimension) was used for calibration. The distance between the platform of the implant and the most coronal point of contact between the bone and the mesial and distal sites of implants was considered. The difference of bone level was measured by a specific software.[‡‡]

The intraexaminer error was calculated by comparing the first and second measurements by a paired *t* test, at a significance level of 5%. No statistical difference was found between values ($P > 0.05$).

The marginal bone loss was evaluated at 12, 24, and 48 months of healing. Mesial, distal, and mean bone loss were calculated both in the maxilla and mandible.

Statistical Analysis

Width of KM was dichotomized using 2 mm as a cutoff point. Group A consisted of implants where the width of KM was ≥2 mm, and group B comprised implants where the width of KM was <2 mm.

A dedicated software was used for all statistical analyses.[§§] Clinical parameters were calculated for each implant and were reported as mean ± SD. Radiographic bone level values (mesial, distal, and mean bone loss) were calculated for each implant and were reported as mean ± SD at 4-year follow-up. To compare the difference between group A and group B mean values, a Student two-tailed *t* test was adopted ($P < 0.05$ was considered the threshold for statistical significance).

RESULTS

After 4-year follow-up, a survival rate of 100% was reported for all implants. The mean values for group B were significantly higher ($P < 0.05$) than group A for the following parameters: GI (group A, 0.67 ± 0.09; group B, 1.01 ± 0.11); modified plaque index (group A, 1.18 ± 0.09; group B, 1.71 ± 0.12); and mBI (group A, 0.35 ± 0.05; group B, 0.78 ± 0.05) (Table 2). There was no statistical difference between the two groups for probing depth. With regard to mBI, implants with a narrow zone of keratinized tissue had a significantly higher probability of bleeding than implants with a wider zone of keratinized gingiva (Table 2). Gingival recession mean values are shown in Table 3. In both

¶ Hu-Friedy PGF-GFS, Hu-Friedy.
# Hu-Friedy PGF-GFS, Hu-Friedy.
** Schick CDR, Schick Technologies, Long Island City, NY.
†† Schick Technologies.
‡‡ Schick Technologies
§§ SPSS 11.5.0, SPSS, Chicago, IL.

Table 2.

Clinical Parameters for Groups A and B at 4-Year Follow-Up

Parameter	Group A	Group B	*P* Value
GI	0.67 ± 0.09	1.01 ± 0.11	0.004
mPI	1.18 ± 0.09	1.71 ± 0.12	0.005
mBI	0.35 ± 0.05	0.78 ± 0.05	0.008
PD (mm)	2.73 ± 0.34	2.81 ± 0.41	0.531

n = 164 implants.
GI = gingival index; mPI = modified plaque index; mBI = modified bleeding index; PD = probing depth.
Group A = KM ≥2 mm; group B = KM <2 mm.

Table 3.

Mean Gingival Recession Values (mm) for Groups A and B

Parameter	Group A	Group B	*P* Value
6-month follow-up	0.19 ± 0.18	0.92 ± 0.26	<0.001
2-year follow-up	0.23 ± 0.15	1.03 ± 0.70	0.002
4-year follow-up	0.24 ± 0.16	1.30 ± 0.80	0.008

n = 164 implants.
Group A = KM ≥2 mm; group B = KM <2 mm.

groups, up to 60% of gingival recession occurred within the first 6 months, and remained stable over time (little increase for group B). Statistically significant differences were found between groups for gingival recession values. At 4-year follow-up, the gingival recession was obtained in 25 implants of group B with a mean value of 1.30 ± 0.80. In the same group, three implants with gingival recession (1.40, 1.60, and 2.00, respectively) presented a mean alveolar bone loss of 1.53 mm, and 2 years after placement, two implants exhibited peri-implantitis process with bone loss of 2 mm. However, the bone levels between group A and group B (0.85 ± 0.23 and 0.99 ± 0.58 mm, respectively) were not statistically different ($P = 0.25$), showing similar values at 4-year follow-up.

The results demonstrated that less width of KM is significantly associated with more gingival inflammation, more plaque accumulation, and more gingival recession. Mesial and distal bone loss are not associated with width of KM.

DISCUSSION

With regard to the alveolar bone, the results from the present study indicated that the average bone loss was not influenced by amounts of KM, because the differences observed in the present study failed to reach statistical significance, confirming that the absence of adequate keratinized/attached mucosa has little to no impact on alveolar bone level.[12] In contrast, Bouri et al.[22] reported association between narrow zones of KM and alveolar bone loss around dental implants. They found the mean GI, PI score, and radiographic bone loss were significantly higher for those implants with a narrow zone of KM. Implants with a narrow zone of KM also were more likely to bleed on probing.

In the present study, two patients in group B with narrow zone of KM presented peri-implantitis with bone loss. This result is explained in experimental study, because dental implants with a titanium plasma spray coating showed that the absence of KM increased the susceptibility to peri-implantitis.[23]

The presence of KM seems to be significantly advantageous for reduction of gingival inflammation, plaque accumulation, and gingival recession. The results of the present study advocate the hypothesis that narrow zones of keratinized gingiva are less resistant to inflammation and may stimulate apical migration of gingival tissues inducing marginal recessions. Conversely, wider zones of keratinized gingiva may offer more resistance to the iatrogenic factors.

In a clinical study,[21] adjustments of the peri-implant soft tissue margin occurring during a 2-year period after insertion of fixed prostheses were evaluated. The descriptive analysis showed a slight decrease in mean probing depth and width of masticatory mucosa during the follow-up period. As reported in the present study, apical displacement of the soft tissue margin mainly took place during the first 6 months of observation. Lingual sites in the mandible showed the most pronounced soft tissue recession, decrease of probing depth, and decrease of width of masticatory mucosa. The statistical analysis revealed that lack of masticatory mucosa and mobility of the peri-implant soft tissue at time of prosthetic restoration were poor predictors of soft tissue recession occurring during the 2 years of follow-up. There was a greater amount of recession in females than in males, in the mandible than in the maxilla, and at lingual than at facial sites with increased initial probing depth. It was suggested that the recession of the peri-implant soft tissue margin may be the result of a remodeling of the soft tissue to establish "appropriate biological dimensions" of the peri-implant soft tissue barrier (i.e., the required dimension of epithelial-connective tissue attachment in relation to the facio-lingual thickness of the supracrestal soft tissue).[21]

The outcome of KM was evaluated in a retrospective study on long-term maintenance of dental implants with regard to the type of implant prostheses (fixed versus removable) and the location of implant placement (anterior versus posterior).[13] The results suggested that the amounts of KM were not

significantly correlated with any clinical parameters of prosthetic restoration either fixed or removable. However, the presence of KM was shown to be significantly advantageous in maintenance of soft tissue health in posterior implants, indicated by higher GI score in posterior implants without adequate amount of KM than those with adequate amount of KM. An interesting finding was that the average bone loss in posterior implants was 3.5-fold higher than that in anterior implants in the presence of an adequate amount of KM.

Conversely, in the present study gingival recession was not related to the position but was correlated to the width of KM, because in the same patients implants placed in the fresh sockets with different KM presented recession around implants with minimal keratinized gingiva.

Similar results were reported in a clinical study of 307 mandibular dental implants placed in 73 completely edentulous patients, and followed over a period of 5 years.[24] In patients exercising good oral hygiene and receiving regular implant maintenance therapy, implants with a reduced width of <2 mm of peri-implant KM were more prone to lingual plaque accumulation and bleeding and buccal soft tissue recession.

CONCLUSIONS

Within the limits of this clinical study, the results suggest that the presence of mid-buccal KM is not a critical factor in the maintenance of interproximal bone level around immediately loaded fresh socket implants. Conversely, sites with less width of KM are significantly associated with more gingival inflammation, more plaque accumulation, and more gingival margin recession.

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