Midfacial Tissue Assessment of the Effect of Amount of Keratinized Mucosa on Immediate Temporarization of Fresh Socket Implants: 8-Year Follow-up

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The aim of the present study was to consider the long-term midfacial mucosal outcome around final prosthetic restorations on dental implants placed and loaded immediately after tooth extractions. A total of 42 patients requiring tooth extractions were recruited, and 142 teeth were extracted. Based on the amount of keratinized mucosa (KM), implants were categorized into group A (KM ≥ 2 mm; n = 61) or group B (KM < 2 mm; n = 62). In both groups, all patients received temporary prosthetic restorations immediately after the surgical procedure. Baseline levels were measured at placement of the final prosthetic restoration and patients were followed for 8 years. After the 8-year follow-up, a survival rate of 98.37% was reported. Two implants were lost due to peri-implantitis after 6 and 7 years of function, respectively. Peri-implantitis occurred at 9 implants (3 from group A and 6 from group B) in 8 patients (7.32%). At the 8-year follow-up for group A, an increase in midfacial tissue level of 0.14 ± 0.13 mm (screwed restorations) and 0.16 ± 0.09 mm (cemented restorations) was measured. For group B, a decrease in midfacial tissue level of 0.15 ± 0.09 mm (screwed restorations) and 0.17 ± 0.12 mm (cemented restorations) was reported. Statistically significant differences between groups were measured at 2, 5, and 8 years of follow-up (P < .01). The results demonstrated that the presence of KM is significantly associated with less mucosal inflammation and less gingival recession, regardless of the type of prosthetic restoration (screwed vs cemented).


Mucosal preservation in implant therapy is dependent on an appropriate width of keratinized masticatory mucosa because of the considerable link between submucosal restoration and gingival inflammation, which can be found in regions affected by minimal keratinized mucosa (KM), particularly in patients with poor plaque control.1,2 Esthetic outcomes are also influenced by peri-implant soft tissues, gingiva levels, color, and texture.3,4 For this reason, a precise assessment of bone and soft tissues around the extraction sockets is fundamental prior to immediate implant placement.5

It can be speculated that an inadequate amount of KM, especially with suboptimal oral hygiene, negatively influences the long-term maintenance of marginal tissues of restored teeth and dental implants. Inflammatory reactions of peri-implant tissues lead to progressive bone loss and have a negative effect on the long-term prognosis of implant procedures.6–8 Other studies have reported mucosal health without any KM,9–11 and a lack of attached mucosa did not negatively affect the maintenance of soft tissue health around dental implants.12 To minimize bone changes and prevent unesthetic scars or mucogingival-level alterations, a flapless approach in fresh socket implants.
has been suggested.\textsuperscript{13,14} Such clinical outcomes are influenced less by implant positioning and more by tooth extraction and modifications to the surgical and restorative procedure.\textsuperscript{15–17} Treatment strategies for the levels of midfacial soft tissue levels are a concern, especially when immediate implant positioning is pursued.\textsuperscript{18} Various cases of immediate implant treatment have shown advanced midfacial recession of $>1$ mm or 10\% of the length of the crown in 18\% to 35\% of cases.\textsuperscript{19–21} Other cases have shown limited recession following immediate implant treatment,\textsuperscript{22} similar to descriptions of conventional implant treatment in healed sites.\textsuperscript{23} While extensive literature has described mucosal adjustment from tooth extraction to final prosthetic restoration, limited data are available on mucosal assessment with immediately loaded fresh socket implants evaluated from final restoration placement with a long follow-up. Since many factors, including anatomy of the prosthetic emergence profile, screw vs cement retention, and external or internal connection, may influence the outcome of mucosal tissue around implant-prosthetic restoration, the aim of the present study is to consider the long-term midfacial mucosal outcome around the final prosthetic restoration on dental implants placed and loaded immediately after tooth extractions.

\section*{Materials and Methods}

\subsection*{Patient Selection}

Patients requiring extraction of two or more monoradicular teeth in the maxilla and mandible due to root fractures, caries, endodontic lesions, or periodontal disease were selected for the present study. Implants were positioned and loaded immediately after tooth extraction. All patients attended the Department of Dentistry, IRCCS San Raffele Hospital, Milan, Italy.

The following inclusion criteria were adopted for each patient: good systemic health, no chronic systemic disease, four bony walls of the alveolus present, and at least 4 mm of bone beyond the root apex. Exclusion criteria were presence of dehiscence or fenestration of the residual bony walls, coagulation disorders, signs of acute infection around the alveolar bone at the surgical site, heavy smoking ($>10$ cigarettes per day), alcohol or drug abuse, and bruxism.

The study protocol was approved by the local institutional review committee 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.

\subsection*{Surgical Protocol}

Patients received 1 g amoxicillin at 1 hour prior to surgery and twice a day for a week after the surgical procedure. Surgery was performed under local anesthesia (mepivacaine [Optocaine, Molteni Dental] 20 mg/ml with adrenaline 1:80,000).

Teeth were extracted, maintaining the integrity of the socket and avoiding buccal and palatal flaps. A periodontal probe (PGFGS, Hu-Friedy) was used to verify the integrity of the four walls of the fresh sockets. All experimental sites showed the absence of fenestration or dehiscence. No regenerative procedures were performed in any sites.

The implant site was prepared with standard drills, following the palatal bony walls as a guide. The apical portion of the implant was always placed at least 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 Type 2 or 3, according to Lekholm and Zarb.\textsuperscript{24}

The titanium dental implants had a 0.8-mm machined neck and a rough-surface (titanium plasma spray) body with a progressive thread design (Outlink, Sweden & Martina) with external hexagon implant-abutment junctions. Implants with diameters of 5, 4.1, and 3.75 mm and a length of 13 mm were used. 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 into group A ($\text{KM} \geq 2$ mm) or group B ($\text{KM} < 2$ mm).

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

**Prosthetic Protocol**

In both groups, immediately after the surgical procedure, all patients received temporary prosthetic restorations. The restorations were cemented with temporary cement (Temp Bond, Kerr) or screwed onto implants, according to a computer-generated randomization list. The single, partial, and complete fixed temporary reconstructions had a fiber-reinforced framework and were customized with acrylic resin along the margins of the abutment. In each case, distal cantilevers were avoided. All temporary crowns were in full contact in centric occlusion, giving the occlusal surfaces flat reducing horizontal relations. All patients followed a soft diet (avoiding bread and meat) for 2 months. After 4 months, final ceramic restorations were placed.

**Follow-up Evaluation**

Follow-up visits were performed by a dental hygienist twice a year for 8 years after implant placement. The following clinical parameters were recorded: gingival index (GI), modified plaque index (mPI), modified bleeding index (mBI) registered at four surfaces of the implants, and probing depth (PD) measured at four points (mesiobuccal, midbuccal, distobuccal, and midlingual) to the nearest millimeter with a pressure-sensitive probe (PGF-GFS, Hu-Friedy), using a standardized pressure of 0.35 N. Marginal mucosal assessment (midfacial tissue level) was calculated as the distance between the soft tissue margin and the supramucosally located incisal margin, measured to the nearest millimeter using the periodontal probe. The width of KM at the midbuccal point was measured from the mucogingival junction to the free gingival margin using a periodontal probe (PGF-GFS, Hu-Friedy). Baseline levels were measured at the time of placement of the final prosthetic restoration. All clinical assessments were performed by one examiner, who before the start of the study was trained and calibrated with respect to the various assessments included in the study (P.C.). Intraexaminer variation was evaluated by means of double assessments of 10 patients. The mean difference between pairs of linear assessments ranged from 0.12 and 0.15 for the variables considered. In 84% to 88% of the sites, the measurements were identical. No difference > 1 mm was recorded.

Success criteria for implant survival were presence of implant stability, absence of radiolucent zone around the implants, no mucosal suppuration, and no pain.

**Statistical Analyses**

KM width 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 with a KM width of < 2 mm.

**Results**

Between December 2006 and February 2008, 42 patients (25 women and 17 men; mean age 52.2 years, range 28 to 71 years) were included in this study. A total of 142 teeth (incisors, canines, and first premolars) were extracted, maintaining the integrity of the socket (Table 1). A total of 123 implants were placed, 61 in group A and 62 in group B. Implant diameter and length for each group are reported in Table 2. In each case, the requested primary stability was obtained and immediate loading was performed. According to the randomization process, 92 crowns were screwed onto the implants and 70 were cemented on temporary abutments.

After 8 years of follow-up, a survival rate of 98.37% was reported for all implants. Two implants were lost.
due to peri-implantitis after 6 and 7 years of function, respectively. Periimplantitis occurred in 9 implants (3 from group A and 6 from group B) in 8 patients (7.32%).

Clinical Parameters

Clinical parameters were compared at 2, 5, and 8 years of follow-up (Table 3). In general, they were stable over time, and no statistically significant differences in GI, mPI, and PD were measured over time between group A and group B or between screwed and cemented restorations (P > .05).

With regard to mBI, implants with a narrow zone of KM had a significantly higher probability of bleeding than implants with a wider zone (Table 3). Indeed, mBI showed significant differences between groups A and B (P < .001) at the 2-, 5-, and 8-year follow-up (Table 3). However, no statistically significant differences were found in intragroup comparison between screwed and cemented restorations.

Midfacial Tissue Level

Midfacial tissue level mean values are shown in Table 4. They were reported at 2-, 5-, and 8-year follow-ups. In general, both groups reported stable levels of midfacial tissue recession; however, statistically significant differences were found. In particular, the thick mucosa group (group A) showed an increase in midfacial tissue level over time, while the thin mucosa group (group B) showed a decrease.

At the 8-year follow-up, an increase in midfacial tissue level of 0.14 ± 0.13 mm (screwed restorations) and 0.16 ± 0.09 mm (cemented restorations) were measured for group A. For group B, a decrease in midfacial tissue level of 0.15 ± 0.09 mm (screwed) and 0.17 ± 0.12 mm (cemented) were reported. Statistically significant differences between groups A and B were measured at 2, 5, and 8 years (P < .01). However, in intragroup comparison, the difference was always not statistically significant (P > .05) in relation to the type of prosthetic rehabilitation (screwed vs cemented).

The results demonstrated that the presence of KM is significantly associated with less mucosal inflammation and less gingival recession, regardless of the type of prosthetic restoration (screwed vs cemented).

Discussion

This study assessed the midfacial gingival margin after final prosthetic restoration to evaluate mucosal tissue outcome at 8 years of follow-up. Volume changes in fresh sockets after implant placement with mucosal and bone remodeling have been reported, but little is known...
about mucosal outcome after final restoration placement after a long-term follow-up. Nevertheless, for an adequate mucosal tissue assessment during temporary prosthetic restoration leading to an adequate final ceramic restoration, the results of the present study advocate the hypothesis that narrow zones of KM are less resistant to inflammation and may stimulate apical migration of mucosal tissues, inducing marginal recession. Conversely, wider zones of KM may offer more resistance to iatrogenic factors. In a clinical study evaluating adjustments of the peri-implant soft tissue margin during a 2-year period after insertion of fixed prostheses, the descriptive analysis showed a correlation between a slight decrease in mean probing depth and width of masticatory mucosa during the follow-up period. In the present clinical study, marginal mucosal gain over time was observed in the thick mucosa group around several prosthetic restorations while other cases showed a marginal gingival recession. This process was difficult to explain, as several factors are likely involved in this process: good hygiene maintenance level, good anatomical relationship between emergence profile of the crown restoration and mucosal shape, and a correct axis of implant loading. Two implants were lost after some years. The failed implants had been placed in anatomical sites where a high hygiene score was difficult to preserve, and over time the inflammatory process induced bone loss. Thin mucosa and plaque accumulation were surely the cause of these implant failures. Three patients experienced peri-implantitis in sites with thick keratinized mucosa, but these acute processes were treated. The presence of KM appears to be significantly advantageous for reduction of mucosal inflammation, plaque accumulation, and gingival recession. The results of the present study advocate the hypothesis that narrow zones of KM are less resistant to inflammation and may stimulate apical migration of mucosal tissues, inducing marginal recession. Conversely, wider zones of KM may offer more resistance to iatrogenic factors. In a clinical study evaluating adjustments of the peri-implant soft tissue margin during a 2-year period after insertion of fixed prostheses, the descriptive analysis showed a correlation between a slight decrease in mean probing depth and width of masticatory mucosa during the follow-up period. In the present clinical study, marginal mucosal gain over time was observed in the thick mucosa group around several prosthetic restorations while other cases showed a marginal gingival recession. This process was difficult to explain, as several factors are likely involved in this process: good hygiene maintenance level, good anatomical relationship between emergence profile of the crown restoration and mucosal shape, and a correct axis of implant loading. Two implants were lost after some years. The failed implants had been placed in anatomical sites where a high hygiene score was difficult to preserve, and over time the inflammatory process induced bone loss. Thin mucosa and plaque accumulation were surely the cause of these implant failures. Three patients experienced peri-implantitis in sites with thick keratinized mucosa, but these acute processes were treated. The presence of KM appears to be significantly advantageous for

Conclusions

In this clinical study, prosthetic restorations were either screwed or cemented on implants. Both restoration types showed the same clinical values, since the relationship between mucosal tissues and prosthetic emergence profile was respected in both connections. KM makes a difference over the long term for wellness of peri-implant tissues. The relationship between thick KM and anatomy of prosthetic crowns may represent an important factor in mucosal tissue behavior.
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References