Preservation of Peri-implant Soft Tissues Following Immediate Postextraction Implant Placement. Part II: Clinical Evaluation

Daniele Cardaropoli, DDS1
Lorenzo Tamagnone, DDS1
Alessandro Roffredo, DDS1
Andrea De Maria, DDS1
Lorena Gaveglio, DDS1

Soft tissue contour changes were evaluated in 20 patients who underwent immediate implant placement with provisional restoration. The bone-to-implant gap was accurately grafted with xenograft prior to implant placement, and enamel matrix derivative was applied prior to delivery of an immediate screw-retained restoration. No significant differences were observed between baseline and 1 year after implant placement in soft tissue contour measurements and the Pink Esthetic Score. Furthermore, no differences were observed between thin or thick biotypes. It was shown that the use of immediate single-tooth implants with immediate restoration resulted in the maintenance of the soft tissue contour and esthetics when compared to pretreatment independently from the soft tissue phenotype.


The bone resorption and remodeling that take place following tooth extraction may considerably affect the external bone crest architecture, which is essential for maintaining favorable functional and esthetic outcomes.1 Experimental studies have shown that bundle bone, a tooth-dependent structure that contains the collagen fibers of the periodontal ligament, is lost after extraction because of the lack of nutrition and is replaced by woven bone.2–4 Bone loss is more pronounced in the buccal wall, as it is mainly composed of bundle bone, and a loss of 50% within 12 months following extraction has been demonstrated.5 Bone resorption takes place in both the maxilla and mandible and mainly affects the overlying soft tissue. A soft tissue loss of 3 to 5 mm has been reported during the initial months following tooth extraction in both humans and animals.4,6–8 Immediate implant placement has been proposed to reduce the bone loss after tooth extraction9 and is suggested to be a reliable treatment option for patients needing tooth replacement in the esthetic area. Advantages of immediate implant placement include reduced overall treatment time, reduced number of surgical procedures, and an optimal availability of existing bone to allow primary stability of the implant.10 While clinical studies have demonstrated

1PROED Institute for Professional Education in Dentistry, Torino, Italy.

Correspondence to: Dr Daniele Cardaropoli, PROED Institute, Corso GalileoFerraris 148, 10129 Torino, Italy.
Fax: +39.011.323683. Email: d.cardaropoli@proed.it

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high survival rates of immediately placed implants, this procedure may also be associated with an increased risk of marginal tissue recession that, in itself, may compromise esthetic outcomes. Therefore, recent literature shows an increased interest in the soft tissue management of immediate implants. Both grafting of the bone-to-implant gap and delivery of an immediate restoration seem to improve the final esthetic outcomes, but their actual influence on soft tissue contour changes of immediate implants is currently unclear. Also, little is known about the effect of biologic mediators on the healing of the fresh extraction-socket wound. The aim of the present study was to evaluate over a 1-year period the soft tissue contour changes at immediately placed and restored anterior maxillary single-tooth implants. Hard tissue evaluation and radiologic measurements were reported in a separate paper.

**Materials and Methods**

Twenty consecutive adult patients who provided written informed consent and agreed to the proposed treatment plan at a private periodontal practice in Turin, Italy, were enrolled in this study. The study protocol was approved by the PROED ethical committee (Turin, Italy). The study was conducted in accordance with Helsinki Declaration of 1975, as revised in 2008. All patients required single tooth extraction in the anterior maxilla (from premolar to premolar). The reasons for extraction included crown/root fracture, endodontic treatment failure, and advanced caries. Patients with acute periodontal or periapical infection were not included. Bone sounding was used to detect presence of intact bone walls, and the integrity of the soft tissue contour at the facial aspect of each tooth was verified at the time of enrollment (Fig 1). The systemic exclusion criteria were current pregnancy, existence of metabolic bone disease, history of malignancy, history of radiotherapy or chemotherapy for malignancy in the past 5 years, history of autoimmune disease, and drug consumption that could interfere with implant therapy. Patients who smoked more than 10 cigarettes per day were also excluded. Patients who smoked less than 10 cigarettes per day were requested to stop smoking for 2 weeks before and after surgery. A comprehensive periodontal examination and professional oral hygiene with scaling and root planing was performed in all patients. Instructions for personal care were delivered to ensure a healthy periodontal environment.

The surgical and prosthetic protocol has been already described. Briefly, in order to provide a prosthetically driven implant position that leaves at least a 2-mm-wide...
bone-to-implant gap (slightly palatal for incisors and canines; centric to the occlusal plane for premolars), a surgical template was fabricated for each patient before surgery. A minimally invasive flapless procedure was performed for all tooth extractions. Maximum care was taken to minimize trauma to the socket walls when gently luxating and extracting the tooth with periotomes (Carda #1 and Carda #2, Maxil) and extraction forceps. The socket was then rinsed with saline solution, and granulation tissue was removed by careful debridement, if needed. The integrity of the alveolar walls was detected using a periodontal probe. In order to expose the underlining connective tissue, the epithelium was excised from the sulcus entrance and the junctional epithelium with a 15-C blade (KAI). An osteotomy was performed to prepare for implant placement according to the manufacturer’s surgical protocol, using the surgical stent as a reference. A final drill was used at a low speed (200 rpm) in order to underprepare the surgical site and improve implant primary stability. The osteotomy engaged a triangle of bone apical and palatal to the apex of the root. The implant platform was positioned subcrestally, approximately 1 mm apical to the margin of the buccal bone wall. A total of 20 bone-level tapered, titanium-zirconium alloy implants with a highly hydrophilic surface (Bone Level Tapered SLActive, Straumann), with a diameter of 3.3, 4.1, or 4.8 mm and a length of 10, 12, or 14 mm, were inserted.

In order to assure perfect threedimensional grafting around the implant threads without voids, the bone-to-implant gap was filled with deproteinized bovine bone mineral (Cerabone, Botiss Biomaterials) before implant placement. This was performed using a specifically designed bone plugger (Carda #4, Maxil) (Fig 2). When no xenograft granules were left inside the previously prepared implant bed, implants were screwed into the surgical sites until final seating. All implants presented a final insertion torque of ≥35 Ncm.

The provisional polymethyl methacrylate screw-retained abutments (RC Temporary Abutment, Straumann) and connection screws were inserted and seated. For each position, a provisional acrylic crown was luted to the provisional abutment with a light-cured composite resin. The crown then underwent chairside refining and polishing. In order to create a full-contoured provisional crown, the composite resin below the free gingival margin was molded with subgingival contours that duplicated the pre-extraction state (Fig 3a). Right before provisional screwing, enamel matrix derivative (EMD; Emdogain, Straumann) was applied in contact with the soft

Fig 2  Following local anaesthesia, the tooth is extracted with a flawless approach to leave the soft tissues intact. The two roots have been separated. Using a surgical template, the implant site is prepared with a prosthetically driven approach, leaving more than 2 mm of future bone-to-implant gap. (a, b) Before implant insertion, the anticipated bone-to-implant gap is carefully grafted using a bovine bone substitute. The implant is then inserted, reaching primary stability in the preexisting apical bone, and is in full contact with the bone substitute at the gap level.
tissue of the newly made socket and above the xenograft granules (Fig 3b). The acrylic crown was screwed on the implant at 15 Ncm and, to avoid any functional loading, occlusion was adjusted (Figs 3c and 3d). Antibiotic therapy (1 g amoxicillin plus clavulanate potassium every 12 hours) was prescribed for 6 days. If needed, ibuprofen (60 mg) was also prescribed. It was requested that all patients use a mouth rinse with 0.2% chlorhexidine gluconate every 8 hours for 14 days.

After 3 months, the provisional restoration was disconnected and an impression was taken with an impression coping. A custom impression of the provisional restoration contours was made to counteract the natural tendency of the mucosal tissue to spontaneously collapse after removal of the provisional crown (Fig 4). The screw-retained definitive full-ceramic crowns were delivered after 2 more weeks (Fig 5).

Clinical Measurements

All measurements were performed by a single person (A.D.) different from the surgeon (D.C.). A blinded examiner (L.T.) evaluated all measurements.

Before tooth extraction (T0) and 1 year after implant placement (T1), the following parameters were measured using an acrylic reference stent: mesial papillary level (MP), distal papillary level (DP), and midfacial gingival level (MG). MP, DP, and
MG were defined as the distance between the reference point on the acrylic stent to the top of the mesial papilla, distal papilla, and midfacial peri-implant mucosa, respectively, measured to the nearest 0.5 mm using a periodontal calibrated probe (PCP15, Hu-Friedy) (Fig 6a). Moreover, the Pink Esthetic Score (PES)
was evaluated. The PES evaluates peri-implant soft tissue around single-tooth implants and is based on seven variables: mesial papilla, distal papilla, soft-tissue level, soft tissue contour, alveolar process deficiency, soft-tissue color, and texture. Each variable is assessed with a score of 0, 1, or 2, with 0 being the poorest and 2 being the best score (Fig 6b); the highest possible score is 14. In order to evaluate the influence of gingival biotype on the final outcomes, following the classification by Olsson and Lindhe, patients were classified and divided into two groups: those with a thin biotype and those with a thick biotype.
Statistical Analysis

A power calculation before the study revealed that a sample size of 20 sites was necessary to detect a difference in soft tissue level of 0.5 mm after 1 year, assuming a maximum standard deviation of 0.7 mm using paired t test with 80% power and a 0.05 level of significance. Statistical analysis was performed using non-parametric Wilcoxon and Kruskal Wallis test, with statistical significance set at $P < .05$. The Wilcoxon signed rank test was used for within-group comparisons between T0 and T1. Kruskal-Wallis test was used for the comparison of esthetic parameters between the groups. For all parameters, mean values and standard deviation were calculated.

Results

All 20 patients who were enrolled completed the 1-year follow-up of the study. The mean age of patients was 58.5 ± 11.03 years (range: 34 to 75 years), and 7 males and 13 females were included. All surgical procedures and prosthetic rehabilitations were performed as planned, and no mechanical or biologic complications were reported. Regarding the safety of the procedure, no adverse events were reported spontaneously by the subjects or observed by the surgeon or his staff. All implants osseointegrated and were in function at 1 year from placement, with a 100% survival rate. Clinical parameters’ results at baseline and 1 year, are summarized in Table 1. No statistical differences were found in the clinical parameters between baseline and 1 year after implant placement. Results of the comparison between the thick (n = 12) and thin (n = 8) gingival biotype for each clinical parameter at baseline and at 1 year after placement are shown in Table 2. No statistical differences were shown between the two biotypes for all clinical parameters measured (Fig 7).

Discussion

This study was performed to evaluate the soft tissue contour changes up to 1 year in 20 patients following single tooth extraction and immediate implant placement with provisional restoration. Immediate implant placement is performed to reduce the overall treatment time, prevent the need for additional surgery, and increase patient comfort. Further, a fixed provisional crown was immediately delivered at the end of the surgery, improving the esthetic outcome, improving psychologic acceptance, and eliminating the need for second-stage surgery and/or wearing a removable provisional prosthesis in an area of high esthetic relevance.

In terms of survival rate, immediate implant placement was considered a success, with 100% survival at 1 year. These results are

| Table 1 Summary of Clinical Results at Baseline and 1 Year After Implant Placement |
|---------------------------------|---|---|---|---|---|
|                                | Baseline | 1 y | Difference | P  |
| PES                             | 12.25 ± 1.25 | 12.55 ± 1.00 | 0.30 ± 1.38 | .42 |
| MP (mm)                         | 5.20 ± 0.70  | 5.23 ± 0.77  | 0.03 ± 0.34 | .74 |
| DP (mm)                         | 5.75 ± 0.80  | 5.78 ± 0.79  | 0.03 ± 0.34 | .74 |
| MG (mm)                         | 8.03 ± 0.50  | 7.95 ± 0.63  | 0.08 ± 0.49 | .44 |

PES = Pink Esthetic Score; MP = mesial papillary level; DP = distal papillary level; MG = midfacial gingival level. Differences were not of statistical significance.

| Table 2 Comparison of Clinical Results Between Thick and Thin Biotypes |
|---------------------------------|---|---|---|---|---|---|---|---|
|                                | PES | MP | DP | MG |
| Biotype                        | T0  | T1 | T0  | T1 | T0  | T1 | T0  | T1 |
| Thin                           | 9.67| 9.25| 11.63| 12.46| 11.00| 11.17|11.50|10.96|
| Thick                          | 11.75|12.38|8.81|7.56|9.75|9.50|9.00|9.81|
| P                              | .42 | .22 | .26 | .06 | .64 | .53 | .28 | .62 |

PES = Pink Esthetic Score; MP = mesial papillary level; DP = distal papillary level; MG = midfacial gingival level; T0 = baseline; T1 = 1 year after implant placement. Differences were not of statistical significance.
supported by a systematic review by Lang et al,\textsuperscript{15} who reported a 2-year survival rate of 98.4\% of implants placed immediately in fresh extraction sockets, with an annual failure rate of 0.82\%.

The results presented herein primarily focus on the changes in soft tissue level at 1 year in relation to the pretreatment status. Soft tissue contour as measured by MP, DP, and MG levels showed no significant changes at 1 year when compared to baseline values. Comparable results have been reported in a previous study showing no difference in soft tissue contour measurements between pretreatment and 1 year after implant placement.\textsuperscript{2} Further, in the present study, the PES was used to evaluate the gingival esthetic appearance around the single-tooth implant. The mean PES value was 12.25 at baseline and 12.55 at 1 year following implant placement, which was not significantly different. These results indicate that immediate implant placement resulted in satisfying and stable esthetic outcomes in the anterior maxilla up to 1 year following implant placement.

No significant differences were reported for the MP, DP, and MG levels and PES scores between the two (thin and thick) gingival biotypes. In a meta-analysis by Kinaia et al, midfacial recession was slightly less after immediate implant replacement in thick gingival biotypes compared to thin ones, but it also was not statistically significant.\textsuperscript{16} Pooled data showed statistically less midfacial recession and better papillary height in the thick-biotype group. In another systematic review, the midfacial mucosal level change was not significantly different between thick and thin gingival biotypes.\textsuperscript{17} These results indicate that immediate implant placement, as proposed in this study, may be recommended for both biotypes.

Immediate implant placement does not prevent bone resorption per se, and marked volume alterations have been reported at the end of the healing period.\textsuperscript{18,19} However, the use of accurate grafting of the bone-to-implant gap for preservation of the buccolingual remodeling of the postextraction ridge is suggested to play a key role. Filling the peri-implant gap with a biomaterial is assumed to promote bone formation and compensate for the postextraction modeling and remodeling of the socket bony walls.\textsuperscript{20,21} This is supported by a previous randomized controlled trial, which demonstrated that untreated control sockets had greater reductions in ridge height and width when compared to the test sockets where the peri-implant gap was grafted with a bone-substitute. While the control sites lost 21.6\% of the original width, the test sites had only an 8.1\% reduction when compared to pretreatment values.\textsuperscript{22} Experimental studies in dogs and in humans have confirmed the positive influence of gap grafting when using xenograft material.\textsuperscript{23,24} The stability of the alveolar ridge volume following tooth extraction and immediate implant placement is obviously related to the stability of the overlying soft tissues. In the present study, EMD was applied to the soft tissues of the newly made socket. In a randomized study, it was shown that topically applied EMD had a positive effect on early periodontal soft tissue wounds.\textsuperscript{25} Tonetti et al compared EMD-treated subjects with non-EMD-treated control subjects who underwent regenerative therapy of deep intrabony defects. The authors showed higher soft tissue densities up to 6 weeks after the procedure in the EMD-treated subjects.\textsuperscript{26} This indicates that earlier gains in soft tissue density following the application of EMD may lead to favorable outcomes.\textsuperscript{27} Looking at the favorable esthetic outcomes reported here, it can be speculated that the immediate topical application of EMD in the fresh postextraction wound after implant placement may positively influence the soft tissue healing, helping to maintain the original profiles in both thin and thick biotypes.

These results point out the importance of protecting and containing the bone graft material during the healing phase of treatment. In this context, a provisional restorative seal seals the peri-implant tissues in the fresh extraction socket, preserving the original gingival contour.

Conclusions

Within the limits of the present study, it can be concluded that:

- Immediate placement and provisionalization of apically tapered implants seems to be an appropriate rehabilitative protocol in intact postextraction sites.
• A combination of accurate grafting of the bone-to-implant gap with application of EMD may help in preserving the original soft tissue contour.

• The stability of the soft tissue profile is independent from the gingival biotype (thick or thin).

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References


