Single-Tooth Replacement in the Maxillary Esthetic Zone with Immediate Implant Insertion and Definitive Abutment Placement and Provisionalization: 1-Year Results of a Prospective Case Series

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This prospective longitudinal study evaluated the peri-implant soft tissue remodeling, marginal bone levels, and implant success rate of immediately placed single implants—which received a definitive zirconia abutment and provisional restoration at implant placement—in the maxillary esthetic zone. The final crown was delivered 7 days later. Patients (n = 26) presenting a single extraction-indicated lateral or central incisor with adequate bone volume were eligible for this study. Mesial and distal papilla levels (MPL and DPL, respectively), facial gingival level (FGL), and mesial and distal marginal bone levels (MMBL and DMBL, respectively) were assessed after 7 days and at 1, 2, 3, 6, and 12 months. Patients were classified according to gingival phenotype: thin (≤ 2 mm) or thick (> 2 mm). After 1 year, the implant success rate was 100%. Mean soft tissue recession was –0.04 ± 0.15 mm (MPL), –0.09 ± 0.02 mm (DPL), and –0.13 ± 0.18 mm (FGL). Mean bone remodeling at 1 year was 0.12 ± 0.17 mm (MMBL) and 0.13 ± 0.18 mm (DMBL). The marginal interproximal bone was above the implant platform in 100% of sites. Patients with thick phenotype showed significantly less papillary recession than thin-phenotype patients. Minimal peri-implant hard and soft tissue changes were observed at the 1-year follow-up.

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An important goal of implant therapy, especially in esthetic areas, is to maintain the long-term stability of peri-implant soft tissue and marginal bone levels. After tooth extraction, loss of hard and soft tissues will occur due to the alveolar process resorption, even in cases of immediate implant placement. However, marginal bone loss and soft tissue recession can be reduced if certain procedures are carried out during immediate implant placement, such as a careful extraction and maintenance of the remaining facial bone, using flapless procedure, placing a narrow implant in the correct three-dimensional position, hard and soft tissue grafting, and immediate provisionalization with a platform-switching concept. Aside from implant loading time (immediate vs delayed), the process of making the implant-supported prosthesis might affect hard- and soft-tissue stability. Traditionally, this process involves a series of dis- and reconnections of the abutment, which can disturb peri-implant tissues. Therefore, placing a permanent abutment immediately after implant placement may help preserve these tissues. Some aspects of the prosthetic abutment, such as the material, could also influence the functional and esthetic outcomes of single implants. Zirconia abutments present favorable biocompatibility and

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mechanical resistance\(^1\) and provide more favorable white and pink esthetics when compared to titanium abutments.\(^{11}\)

This study evaluated the peri-implant hard and soft tissue changes and assessed the 1-year implant success rate around single, immediately placed implants in the maxillary esthetic zone, which received a definitive zirconia abutment and immediate provisional restoration, followed by a definitive crown 7 days after surgery.

**Materials and Methods**

**Patient Selection**

This prospective study was conducted at the Foundation for Scientific and Technological Development of Dentistry (FUNDECTO) at the Dental School of the University of São Paulo (USP) in Brazil. The Institutional Review Board approved the protocol.

Patients were included if they met the following inclusion criteria: (1) needing extraction of a maxillary lateral or central incisor; (2) aged ≥ 18 years; (3) having a gingival contour harmonious with the adjacent dentition; (4) natural opposing dentition present; (5) intact facial bone wall; and (6) adequate bone volume to receive a NobelActive implant (Nobel Biocare) of at least \(3.5 \times 13.0\) mm, with at least 2 mm between the implant and the facial bone wall and 1.5 mm between the implant and proximal aspects of the adjacent teeth.

Patients were excluded if they presented with: (1) a smoking habit (> 10 cigarettes/day); (2) systemic diseases; (3) poor oral hygiene; (4) periodontal disease or active infection around the extraction-indicated tooth; (5) severe bruxism, clenching habits, or malocclusion; (6) damage of the bone walls following tooth removal and/or implant osteotomy; (7) lack of primary implant stability (< 35 N/cm); and (8) no local conditions for placing the implant at the desired position.

**Clinical Procedures**

A provisional crown and a surgical guide were made based on the prosthesis position using heat-polymerized acrylic resin (Jet, Clássico). Patients received careful oral hygiene instructions and oral prophylaxis, followed by a rinse with chlorhexidine mouthwash 0.12% (for 1 minute) before surgery. The indicated tooth wasatraumatically extracted with a flapless procedure. After preparing the implant sites according to the manufacturer-recommended surgical drilling protocol, implants (NobelActive, Nobel Biocare) at least \(3.5\) mm in diameter were placed with the aid of the surgical guide at the prosthetically driven three-dimensional position for a cemented crown. There was a minimum gap of 2 mm between the implant and the internal surface of the facial bone wall. Primary stability (35 Ncm) was confirmed with hand torque. After, zirconia abutments (Procera Esthetic Abutment, Nobel Biocare) were placed using the recommended torque of 35 Ncm. The restorative margins were positioned as shallow as possible (0.5 to 1 mm submucosal). Minor abutment modifications were done when necessary, under copious irrigation, to match the gingival contour of the patient and/or to obtain a favorable shape for crown cementation. Subsequently, the gap between the implant and the bone wall was filled with a xenogeneic bone graft (Bio-Oss collagen, granule size 0.25 mm, Geistlich Pharma).

An impression was made in the same session to fabricate the definitive crown (Lithium disilicate [LiSi2] crystallized [IPS e.max, Ivoclar Vivadent]). A rubber dam was adapted above the definitive abutment margin, prior to the impression, to protect the site. All temporary crowns were temporarily cemented (RelyX, 3M ESPE) after occlusal adjustment. Amoxicillin (875 mg, twice daily for 7 days) and analgesics were prescribed. Patients were instructed to take care of the surgical site and avoid any function on the tooth for approximately 10 to 12 weeks, to have a liquid diet for the first week and a soft diet for the subsequent 4 weeks, and to apply 0.12% chlorhexidine gel (PeriKin, Kin Laboratories) twice daily for 1 week. After 1 week with the temporary crown, the definitive crown was cemented (Zinc Phosphate Cement, Pro-Line), and residual excess cement was carefully removed. Restorations were cleared of all contact in centric occlusion and during eccentric movements. The clinical procedure is shown in Fig 1.
Data Collection

The same trained and calibrated examiner (G.M.R.) collected the following data at 7 days (baseline); at 1, 2, 3, and 6 months; and 1 year after implant placement: gingival phenotype, mesial and distal marginal bone level (MMBL and DMBL, respectively), facial gingival level (FGL), and mesial and distal papilla level (MPL and DPL, respectively). These data were later used to calculate the implant success rate.

Gingival phenotype of patients was classified as thin or thick according to the thickness of marginal gingiva, measured before tooth extraction. A reference point 2 mm apical to the gingival margin, was defined using a periodontal probe. Subsequently, an endodontic K file (#25; Dentsply Sirona) was inserted at the midfacial aspect of the tissue, with a rubber stopper, until the underlying bone was contacted. The measurement was then verified with an Endo Ruler (Dentsply Sirona). Gingival thickness ≤ 2 mm was categorized as a thin phenotype, and gingival thickness > 2 mm was categorized as a thick phenotype.

MPL and DPL were measured with a bow compass (Blue Dolphin Products) from the tip of the papilla to the base of the contact point, which was identified using dental floss. All measurements were checked on duplicate digital photographs, with and without the presence of the compass and dental floss.

FGL was also measured with a bow compass (Blue Dolphin Products) accessing the implant crown length (IC) at each follow-up period. IC was measured at the center of the crown, from the incisal edge to the gingival margin.

The MMBL and DMBL adjacent to implants were measured from intraoral digital radiographs. Images were acquired with a Digora phosphor plate system (Soredex). Exposures were performed with a Yoshida Kaycor X-70S (Yoshida Dental; 70 kVp, 15 mA, periapical x-ray model, 0.35-second exposure time) using the long-cone technique with standardized parallel support for each patient. All patients had a radiograph positioning jig individualized with polyvinyl siloxane. The images were...
exported in DICOM (Digital Imaging and Communications in Medicine) format and analyzed to determine the marginal bone level, using an OsiriX Dicom Viewer (version 9.0, Pixmeo) with a bone convolute filter ($3 \times 3$) at 300% magnification. Bone levels were defined in millimeters, from the implant shoulder to the first bone-to-implant contact on the mesial and distal surfaces. Positive or negative values were given if bone was above or below the implant platform, respectively. To compensate for radiograph distortion, the distance was calibrated to the total length of the implant, using the selected software. MPL, DPL, FGL, MMBL, and DMBL changes were calculated as the difference between the respective parameter value and that from the previous follow-up period and from the baseline.

Implant success rate at 1 year was calculated based on the criteria published by Smith and Zarb.13

Statistical Analysis

The patient/implant was the statistical unit. Patients with thin and thick gingival phenotypes were compared regarding point estimates and clinical parameter changes from baseline with independent $t$ tests. Intragroup changes over time were analyzed with paired $t$ tests. Patients were categorized as presenting a major (>$2$ mm), minor (1 to $2$ mm), or no (<$1$ mm) peri-implant soft tissue discrepancy, or gain of soft tissue. The association between changes and gingival phenotype was analyzed using chi-square test. The significance level was set at 5%. Data were analyzed using SPSS (version 17, IBM).

Results

From 2013 to 2016, 34 patients fulfilled the eligibility criteria and were included in the study. After tooth extraction, 5 patients were excluded due to facial bone fracture. During implant placement, 3 patients were excluded because of a lack of primary implant stability. The remaining 26 patients (15 women, 11 men; mean age: 35 years) comprised 7 maxillary lateral incisors and 19 maxillary central incisors, all treated with single immediate implants and followed up for 12 months. No complications or adverse events were reported. Reproducibility of the measurements was calculated for the intra-examiner error. The intraclass correlation coefficient was > 90% or MPL, DPL, FGL, MMBL, and DMBL.

Between baseline and 1 year, mean changes of $-0.04 \pm 0.15$ mm, $-0.09 \pm 0.02$ mm, and $-0.13 \pm 0.18$ mm were reported for MPL, DPL, and FGL, respectively. Regarding marginal bone levels, mean changes of $0.12 \pm 0.17$ mm and $0.13 \pm 0.18$ mm occurred at MMBL and DMBL, respectively.

After 1 year of follow-up, 100% of the measured sites had the marginal interproximal bone coronal to the implant platform. Figure 2 shows periapical radiographs from an implant at baseline, 30 days, 90 days, and 1 year. Soft tissue recession occurred only up to 60 days (Table 1). After that, either soft tissue gain or no change was seen up to 1 year. There were significant intragroup differences in FGL and DPL, from days 7 to 30, in patients with a thin phenotype ($P < .05$).

Fig 2 Radiographic views of the maxillary right central incisor shown in Fig 1. (a) Extraction-indicated tooth. External root resorption can be seen. (b) Implant at baseline, (c) 30 days, (d) 90 days, and (e) 1 year.
Dimensional changes of MPL, DPL, FGL, MMBL, and DMBL at each follow-up period compared to the anterior follow-up period are reported in Table 1, and the dimensional changes of MPL, DPL, FGL, MMBL, and DMBL of each follow-up period compared to baseline are reported in Table 2. Table 3 reports the frequency distribution of a major discrepancy (> 2 mm), minor discrepancy (1 to 2 mm), no discrepancy (< 1 mm), or gain of the peri-implant soft tissue, based on the changes between baseline and 1 year.

The implant success rate, according to the Smith and Zarb13 criteria, was 100% at the 1-year follow-up.

Discussion

Several studies have assessed the outcome of immediate implant placement in esthetic areas.1–3,5–7,9,14 However, few studies have applied the one abutment–one time concept to implants placed in fresh postextraction sockets.15–19 The present study showed a 100% cumulative implant success rate, consistent with other short-term studies of immediate implant and abutment placement in fresh postextraction sockets.15–19 Peri-implant parameters of hard and soft tissues showed minimal variability at the follow-up periods. Soft tissue recession occurred only up to the 60-day follow-up. Afterwards,
no soft tissue changes were seen, and some sites demonstrated soft tissue gain. After 1 year, mean soft tissue changes of −0.04, −0.11, and −0.09 mm were observed at MPL, FGL, and DPL, respectively. These values are comparable with those observed by Degidi et al.17 and Esposito et al.19 Regarding bone loss, mean MMBL and DMBL after 1 year were 0.12 and 0.13 mm, respectively, in the present study; these results are also similar to those reported by Esposito et al.19 In the present study, patients with a thin gingival phenotype demonstrated more soft tissue recession than patients with a thick phenotype. A systematic review demonstrated that immediate implant placement and provisionalization in a thick phenotype had less midfacial recession and better papillary height than placement at a thin phenotype or a delayed restoration.14 Regarding bone remodeling, minimal changes were verified at each interval (range: 0.00 to 0.05 mm). Although patients with a thin phenotype exhibited larger bone remodeling, there was no significant difference between the different phenotypes at any time point. All patients demonstrated bone remodeling after 1 year, and the bone level was above the implant platform in all cases, independent of the phenotype.

The soft and hard tissue stability observed in the present study may be related to some aspects of the treatment, such as the careful

<table>
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<th>Table 2 Dimensional Changes of the Peri-implant Mucosa and Bone Levels of Each Follow-up Period Compared to Baseline</th>
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<td>Mesial papilla level, mm</td>
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<td>Thin</td>
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<tr>
<td>Thick</td>
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<tr>
<td>P</td>
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<tr>
<td>Facial gingival level, mm</td>
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<tr>
<td>Thin</td>
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<td>Thick</td>
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<td>P</td>
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<tr>
<td>Distal papilla level, mm</td>
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<tr>
<td>Thin</td>
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<td>Thick</td>
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<td>P</td>
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<td>Mesial marginal bone level, mm</td>
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<td>Thin</td>
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<td>Distal marginal bone level, mm</td>
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Bold values indicate a significant intragroup difference compared to baseline (7 days postoperative).
For soft tissues, positive values indicate tissue gain and negative values indicate tissue recession (compared to baseline). For bone tissue, positive values indicate tissue loss and negative values indicate tissue gain (compared to baseline).
*Statistically significant difference between thin (n = 20) and thick (n = 6) phenotype groups.
Table 3 Frequency Distribution of Discrepancies Based on the Changes Between Baseline and 1 Year

<table>
<thead>
<tr>
<th>Phenotype</th>
<th>Gain</th>
<th>No discrepancy (&lt; 1 mm)</th>
<th>Minor discrepancy (1–2 mm)</th>
<th>Major discrepancy (&gt; 2 mm)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mesial papilla level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thin</td>
<td>0 (0%)</td>
<td>20 (100%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>.06</td>
</tr>
<tr>
<td>Thick</td>
<td>2 (33.3%)</td>
<td>4 (66.6%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td></td>
</tr>
<tr>
<td>FGL center</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thin</td>
<td>0 (0%)</td>
<td>20 (100%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>1.00</td>
</tr>
<tr>
<td>Thick</td>
<td>0 (0%)</td>
<td>6 (100%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td></td>
</tr>
<tr>
<td>Distal papilla level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thin</td>
<td>0 (0%)</td>
<td>16 (80%)</td>
<td>4 (20%)</td>
<td>0 (0%)</td>
<td>.70</td>
</tr>
<tr>
<td>Thick</td>
<td>0 (0%)</td>
<td>6 (100%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
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FGL = facial gingival level (crown length).
Data are presented as n (%). The thin phenotype group comprised 20 patients, and the thick phenotype group comprised 6 patients.
*Fisher exact test.

Patient selection criteria, careful tooth extraction with preservation of the alveolar bone walls (focusing on the facial bone wall), the ideal three-dimensional position of the implant guided by the prosthetic design, and the flapless surgery with papilla maintenance, to minimize papilla loss. Further, the use of a smaller-diameter implant (associated with significantly reduced soft tissue recession), the fact that facial gaps ≥ 2 mm between the implant and the bone were filled with a xenogeneic graft, and the use of the platform-switching concept (in connection with the one abutment–one time concept) with zirconia abutments must be highlighted.

The short follow-up period (1 year) and the limited sample size were the main limitations of the present study. Studies with longer follow-up are needed to confirm the long-term hard and soft tissue stability.

Conclusions

Minimal hard and soft tissue recession were observed at the 1-year follow-up. A thick gingival phenotype was associated with less papillary recession than a thin phenotype.

Acknowledgments

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References


