Clinical and Radiologic Evaluation of a Fully Tapered Implant with Immediate Placement in the Esthetic Zone: A Prospective Case Series Study

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A fully tapered implant was recently introduced to increase primary stability and to be used in challenging situations. Twenty single implants were inserted in maxillary postextraction sockets, from premolar to premolar, and immediately restored. Marginal bone level (MBL) and probing depth (PD) were evaluated over a 12-month follow-up period. All implants osseointegrated, achieving a success rate of 100%. The difference in MBL between implant placement and 1 year later was 0.20 ± 0.04 mm, while PD was 2.82 ± 0.51 mm at 1 year. The data reported here support the use of a fully tapered implant for immediate placement and immediate provisionalization for single-tooth replacements in the esthetic area. Int J Periodontics Restorative Dent 2022;42:631–637. doi: 10.11607/prd.5682

A fundamental prerequisite to achieving implant osseointegration is primary stability.1–4 Implant stability may be related to a number of factors, as recipient bone characteristics,5 surgical technique, and implant design.6 Over the years, implant systems and drilling protocols have been developed to implement stability.7,8 Moreover, bone healing seems to be affected by loading protocol.9,10

Immediate implant placement is a surgical procedure presenting positive results,11,12 leading to a bone-to-implant contact comparable to that seen on implants placed in healed ridges.13 When combined with an immediate restoration, this approach is particularly appreciated by patients, as it is less time-consuming and helps achieve satisfactory esthetic outcomes.14–16 When focusing on marginal bone levels, platform-switching implants seem to reduce peri-implant bone remodeling and resorption.17,18

Recently, a new implant system was introduced that is fully tapered, presents a self-cutting thread design, and has an internal conical implant-abutment connection at the bone level (BLX, Straumann).

Aim of this study was to evaluate the 1-year implant and bone stability of the new Straumann BLX implant following immediate placement and immediate restoration.
The secondary objective was to assess esthetic outcomes using the pink esthetic score (PES).

Materials and Methods

This is a prospective single cohort nonparallel clinical study. Twenty consecutive adult patients who were undergoing dental treatment at a private periodontal practice in Torino, Italy, and required a single tooth extraction in the anterior maxilla (premolar to premolar) were enrolled. One representative clinical case is shown in Fig 1. The study population consisted of 12 men and 8 women with a mean age of 63.05 ± 12.60 years (range: 39 to 79 years).

Before enrollment, the integrity of the extraction site was detected by clinical and radiologic means. Only Class I sites were included, evaluated according to Cardaropoli et al's classification (intact sockets, with integrity of the buccal bone plate, no gingival recession, with adequate bone volume for immediate implant placement) (Fig 2). The integrity of the socket was checked again after tooth extraction. The reasons for extraction included crown/root fracture, endodontic treatment failure, and advanced caries. Patients with acute periodontal or periapical infections were not included. The systemic exclusion criteria were the existence of metabolic bone disease, current pregnancy, 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, and those who smoked 10 or fewer cigarettes per day were requested to stop smoking for 2 weeks before and after surgery. In all patients, a comprehensive periodontal examination was performed, followed by oral hygiene professional care and instructions, with scaling and root planing if indicated, to ensure a healthy periodontal environment. The study protocol was approved by the ProEd ethical committee (Torino, Italy). The study was conducted in accordance with 1975 Declaration of Helsinki, as revised in 2008. All study participants accepted the proposed treatment plan and signed written informed consent. All measurements were performed by a single person (A.R.) different from the surgeon (D.C.). A different examiner (L.T.) evaluated all measurements. To provide prosthetically driven implant positioning (slightly palatal for incisors and canines, centric to the occlusal plane for premolars), a surgical template was fabricated for each patient.

Local anesthesia was administered, and tooth extraction was performed using a flapless procedure. If present, granulation tissue was debrided, and the socket was rinsed with saline solution. Using a 15C blade, the inner epithelium was also removed from the sulcus entrance and the junctional epithelium in order to expose the underlining connective tissue. At this time, an osteotomy was performed to prepare for the implant bed, using the surgical stent as a reference and following a partial under-preparing protocol. Implants were then placed mechanically with an implant surgery unit (iChiropro, Bien Air) set at 45 Ncm in order to achieve optimal primary stability. The implant platform was located subcrestally, approximately 1 to 1.5 mm apical to the margin of the buccal bone wall.

A total of 20 bone-level implants with a hydrophilic surface were placed (BLX SLActive Roxolid, Straumann). Implant diameters were 3.75 or 4.5 mm, and lengths were 12 or 14 mm. The bone-to-implant gap was grafted with a deproteinized bovine bone mineral (Cerabone, Botiss Biomaterials). Provisional titanium alloy screw-retained abutments (RB/WB Temporary Abutment, Straumann) were placed, and the connection screws were seated. In each case, the provisional acrylic crown was luted to the provisional abutment using a light-cured composite resin, refined and polished chairside, and finally screwed on the implant at 15 Ncm. The composite resin below the free gingival margin was molded in order to create a full-contoured provisional crown, with subgingival contours that duplicated the preextraction state. The occlusion was adjusted in order to avoid any contact during lateral and protrusive movements and to provide a light infra-occlusion (no contact using the 12-µm paper and contact using the 200-µm paper). Antibiotic therapy with 1 g amoxicillin plus clavulanate potassium (every 12 hours) was prescribed for 6 days. Ibuprofen (600 mg) was also prescribed but assumed only on demand. The patients were asked to use a 0.2% chlorhexidine gluconate mouthrinse.
Fig 1 Example of a clinical case with immediate implant placement. (a) Baseline clinical situation. A maxillary lateral incisor has a fracture at the base of the clinical crown. (b) Intraoral radiographic view showing the lateral incisor root. (c) The root was extracted with a flapless, minimally invasive approach. (d) The fully tapered BLX implant. (e) A BLX implant (3.75-mm diameter, 14-mm length) was inserted slightly palatally, leaving a bone-to-implant gap that was more pronounced on the buccal side. (f) The bone-to-implant gap was filled with bovine bone mineral. (g) A provisional titanium abutment was connected and (h) luted to a provisional resin crown. (i) Intraoral radiographic view at the end of the surgery. (j) Clinical and (k) radiographic views after 3 months of healing. (l) Clinical and (m) radiographic views of the definitive ceramic crown after 6 months of healing. (n) Clinical and (o) radiographic views after 12 months of healing.
every 8 hours for 14 days. After 3 months of healing, the immediate provisional restoration was disconnected, and a digital impression (Trios, 3Shape) was taken. After 2 more weeks, the screw-retained ceramic crowns were delivered using definitive abutments (RB/WB Variobase, Straumann).

**Clinical and Esthetic Measurements**

Three months (T1), 6 months (T2), and 12 months (T3) after implant placement, probing depth (PD) and bleeding on probing (BOP) were measured at the following implant locations: mesial, buccal, distal, and lingual.

In order to objectively examine the esthetic outcome of the implant crowns, intraoral pictures were taken at T2 and T3 and were analyzed to assess the complete PES. The PES evaluates peri-implant soft tissues 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; the highest possible score is 14, representing the optimum esthetic outcome. The threshold of clinical acceptability was set at a value of 9 (out of 14).

**Radiographic Measurements**

At implant placement (T0, baseline), T1, T2, and T3, standardized digital intraoral radiographs were taken for each implant using the parallel long-cone technique (Hy-Scan, MyRay). Radiographs were saved and then evaluated using the ImageJ software (National Institutes of Health). The software was calibrated for every single image using the known length of the implant. Linear measurements on the digital radiographs were performed by...
a previously calibrated examiner (A.R.) using the software’s own measurement tool. Marginal bone level (MBL) was measured as the distance from the interproximal bone to the reference point on the outer aspect of the implant shoulder, done at both the mesial (mMBL) and distal (dMBL) sides, and their mean values were calculated.

**Implant Survival and Success**

Implants were classified as successful and surviving according to the following definitions:

- A surviving implant is an implant that is in place at the time of follow-up.
- A successful implant is an implant that meets all of the following criteria: (1) absence of persistent subjective complaints, such as pain, foreign body sensation, and/or dysesthesia; (2) absence of a recurrent peri-implant infection with suppuration; (3) absence of mobility; (4) absence of a continuous radiolucency around the implant.
- A nonsurviving implant was considered unsuccessful.

**Statistical Analysis**

MBL and PD measurements were expressed in millimeters, and the samples were described with means and standard deviations. BOP was expressed as a dichotomous value, and it was described as an absolute value and percentage of positive or negative bleeding sites. All linear measurements were analyzed with a nonparametric statistical method for paired data and multiple comparisons (Friedman test) and post hoc by Wilcoxon test and Bonferroni correction. Multiple comparison of BOP values was performed with Cochran Q test. Statistical significance was set at $P < .05$. All statistics were calculated with SPSS version 25 (IBM).

**Results**

All patients completed the study, and all surgical and prosthetic procedures were performed as planned. All implants were placed with a minimum insertion torque of 45 Ncm.

Regarding the safety of the procedure, no adverse events were reported spontaneously by the subjects or were observed by the surgeon or his staff. Neither implant- nor procedure-related adverse events were reported.

All implants osseointegrated and were in function at 1 year from placement/loading, with a 100% survival rate. All implants fulfilled the success criteria (100% success rate).

Mean PD was 3.02 ± 0.6 mm at T1, 2.87 ± 0.53 mm at T2, and 2.82 ± 0.51 mm at T3. The difference between T1 and T3 was 0.20 ± 0.09 mm ($P = .011$), while the difference between T1 and T2 was 0.15 ± 0.07 mm ($P = .008$) and the difference between T2 and T3 was 0.05 ± 0.02 mm ($P = .157$). PD values and related statistical analysis are reported in Appendix Tables 1 and 2 (available in the online version of this article at quintpub.com/journals).

BOP was 7.5% (six positive sites) at T1, 8.75% (seven positive sites) at T2, and 10% (eight positive sites) at T3. No statistical difference was found when comparing BOP values at different time points.

Mean PES values were 11.15 ± 0.99 at T2 and 11.55 ± 0.76 at T3. At both timelines, the threshold of clinical acceptability (minimum value of 9) was largely exceeded.

At T0, mean mMBL was –2.28 ± 0.51 mm, while mean dMBL was –2.18 ± 0.49 mm. The total mean MBL at T0, intended as an average value between mMBL and dMBL, was –2.23 ± 0.47 mm. The difference between mean MBL at different time points were as follows: between T0 and T1 was 0.12 ± 0.01 mm ($P = .007$), between T0 and T2 was 0.15 ± 0.02 mm ($P = .003$), between T0 and T3 was 0.20 ± 0.04 mm ($P = .001$), and between T2 and T3 was 0.05 ± 0.01 mm ($P = .109$). Radiologic data and the related statistical analysis are reported in Appendix Tables 3 and 4.

**Discussion**

This study was performed to evaluate the use of a fully tapered implant design (BLX, Straumann) with immediate placement and provisionalization. Results were evaluated over a 1-year follow-up. Both survival and success rates were 100% at 1 year.

PD remained fairly stable during the follow-up period, with a minimal change (0.2 mm) from T1 to T3 (no clinical significance). Likewise, BOP...
never exceeded 10% during the evaluation period, confirming the absence of inflammation in the peri-implant soft tissues.

Further, in the present study, PES was used to evaluate the gingival esthetic appearance around the single-tooth implant. After implant placement, the mean PES values were 11.15 at T2 and 11.55 at T3. At both time points, the threshold of clinical acceptability was largely exceeded.

These results indicate that immediate placement resulted in satisfying and stable esthetic outcomes in the anterior maxilla up to 1 year after implant placement, as already published in the literature.16 These outcomes need to be monitored to evaluate the risk for midbuccal marginal tissue recession over time. The stability of the MBL is also comparable to (1) those of implants inserted in completely healed ridges and (2) positive results reported in literature for immediate implants.22

The BLX is a fully tapered implant with a self-cutting thread design, introduced to improve primary stability in clinically challenging situations,23 as in cases of immediate placement into postextraction sites24 or when immediate restoration is planned.25,26 In the present study, this implant design achieved favorable outcomes in terms of MBL stability, soft tissue health, and success rates.

Conclusions

Within the limits of the present study, it can be concluded that the fully tapered BLX implant can be used for immediate placement and immediate provisionalization of esthetic single-tooth replacements and lead to favorable and stable clinical and radiographic outcomes.

Acknowledgments

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References


### Appendix Table 1 Probing Depth Values at Each Follow-up Time

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>Friedman test</th>
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</thead>
<tbody>
<tr>
<td>mPD</td>
<td>2.85 ± 0.67</td>
<td>2.75 ± 0.64</td>
<td>2.7 ± 0.66</td>
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<tr>
<td>bPD</td>
<td>3.3 ± 0.92</td>
<td>3.1 ± 0.85</td>
<td>3.05 ± 0.83</td>
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<tr>
<td>dPD</td>
<td>2.9 ± 0.64</td>
<td>2.75 ± 0.55</td>
<td>2.7 ± 0.47</td>
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</tr>
<tr>
<td>IPD</td>
<td>3.05 ± 0.89</td>
<td>2.9 ± 0.85</td>
<td>2.85 ± 0.81</td>
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</tr>
<tr>
<td>mnPD</td>
<td>3.02 ± 0.60</td>
<td>2.87 ± 0.53</td>
<td>2.82 ± 0.51</td>
<td>P &lt; .05</td>
</tr>
</tbody>
</table>

PD = probing depth; mPD = mesial PD; bPD = buccal PD; dPD = distal PD; IPD = lingual PD; mnPD = mean PD; T1 = 3-month follow-up; T2 = 6-month follow-up; T3 = 12-month follow-up. Values are presented in millimeters as means ± SDs.

### Appendix Table 2 Post Hoc Test for Mean Probing Depths

<table>
<thead>
<tr>
<th>Follow-up</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
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<tbody>
<tr>
<td>T1</td>
<td></td>
<td>P &lt; .0166</td>
<td>P &lt; .0166</td>
</tr>
<tr>
<td>T2</td>
<td>P &lt; .0166</td>
<td></td>
<td></td>
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<tr>
<td>T3</td>
<td></td>
<td>P &lt; .0166</td>
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</table>

T1 = 3-month follow-up; T2 = 6-month follow-up; T3 = 12-month follow-up. Wilcoxon test and Bonferroni correction were used to determine P values.

### Appendix Table 3 Marginal Bone Level Values at Each Follow-up Time

<table>
<thead>
<tr>
<th></th>
<th>T0</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>Friedman test</th>
</tr>
</thead>
<tbody>
<tr>
<td>mMBL</td>
<td>−2.28 ± 0.51</td>
<td>−2.14 ± 0.51</td>
<td>−2.10 ± 0.50</td>
<td>−2.05 ± 0.46</td>
<td></td>
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<tr>
<td>dMBL</td>
<td>−2.18 ± 0.49</td>
<td>−2.08 ± 0.48</td>
<td>−2.05 ± 0.49</td>
<td>−2.00 ± 0.46</td>
<td></td>
</tr>
<tr>
<td>mnMBL</td>
<td>−2.23 ± 0.47</td>
<td>−2.11 ± 0.47</td>
<td>−2.08 ± 0.47</td>
<td>−2.03 ± 0.43</td>
<td>P &lt; .05</td>
</tr>
</tbody>
</table>

MBL = marginal bone level; mMBL = mesial MBL; dMBL = distal MBL; mnMBL = mean MBL; T0 = implant placement (baseline); T1 = 3-month follow-up; T2 = 6-month follow-up; T3 = 12-month follow-up. Values are presented in millimeters as means ± SDs.

### Appendix Table 4 Post Hoc Test for Mean Marginal Bone Levels

<table>
<thead>
<tr>
<th>Follow-up</th>
<th>T0</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td></td>
<td></td>
<td></td>
<td>P &lt; .0125</td>
</tr>
<tr>
<td>T1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td></td>
<td></td>
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<tr>
<td>T3</td>
<td></td>
<td>P &lt; .0125</td>
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</table>

T0 = implant placement (baseline); T1 = 3-month follow-up; T2 = 6-month follow-up; T3 = 12-month follow-up. Wilcoxon test and Bonferroni correction were used to determine P values.