Single-Tooth Immediate Placement and Provisionalization with Subcrestally Angulated Implants in Sites with Hard and Soft Tissue Facial Dehiscence in the Esthetic Zone: An Observational Study with 2 to 5 Years of Follow-up

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This study evaluated the survival and esthetic outcome of flapless postextraction placement and provisionalization in compromised single tooth sites in the esthetic area. Ten patients were included in the study, and 10 subcrestally angled (SCA) tapered implants were placed. Only maxillary central or lateral incisors and canines were included. Implants showed 100% survival rate, a limited mean marginal bone loss of 0.43 ± 0.23 mm, and a mean gain in coronal gingival level of 1.6 ± 1.17 mm; the mean vertical alveolar bone gain was 4.0 ± 1.5 mm, and the average pink esthetic score was 12.5 at a mean 3.5-year follow-up (range: 2 to 5 years). These results show that immediate replacement and restoration of a tooth with compromised hard and soft tissue condition in the esthetic area, with simultaneous use of connective tissue, bone graft, and membrane, could be a valid alternative to a more complex staged approach. Int J Periodontics Restorative Dent 2022;42:e133–e142. doi: 10.11607/prd.6049

Immediate replacement of a hopeless single tooth with an implant in the anterior maxilla (the esthetic zone) immediately after tooth extraction has become common practice, owing to shorter treatment times, decreased patient discomfort, and lower costs compared to traditional delayed techniques. In the prominent maxillary sites—like the central incisors, lateral incisors, and canines—it is often desirable for esthetic reasons to place a temporary crown simultaneously with implant placement (immediate loading).

Even out of occlusion, immediate loading subjects the implant to forces from the tongue and oral cavity. However, multiple studies have shown that immediately placed and loaded implants experience comparable facial bone remodeling to delayed placement, and consequently better esthetic results, provided there is adequate facial bone width, interproximal distance, and correct three-dimensional placement.

In the event of severe bone deficiencies in the esthetic zone, immediate placement and loading may still be viable alongside bone and soft tissue grafting. This article presents the results of immediately placed and temporized subcrestally angled (SCA) implants for the restoration of single teeth in the esthetic zone possessing hard and soft
tissue deficiencies, in conjunction with soft tissue and bone grafting, up to 5 years postloading.

**Materials and Methods**

Between January 2016 and December 2019, patients at one private dental clinic who required replacement of a single tooth with hard and soft tissue deficiencies in the maxillary anterior zone (incisors or canine area) were considered for inclusion in the study. All subjects were thoroughly informed about the risks and benefits associated with the procedure and signed an informed consent form in accordance with the Declaration of Helsinki for investigations in human subjects. The main inclusion requirement was a minimum vertical bone loss of 5 mm, up to a complete bone dehiscence of the alveolar facial wall, and presence of soft tissue recession. All study subjects were at least 20 years old.

Both smokers and nonsmokers were included, and their smoking status was recorded. Patients with systemic disorders that precluded surgical treatment were excluded, as were those with active pathology of the adjacent teeth. However, the presence of a periapical lesion at the extraction site was not considered to be cause for exclusion. Other inclusion criteria were (1) the presence of a single tooth with a compromised alveolar facial wall, soft tissue deficiency, and a hopeless prognosis due to periodontal disease, decay, endodontic failure, or fracture; (2) the possibility to place an anatomically tapered SCA screw-shaped implant immediately after extraction of the hopeless tooth; (3) achievement of an insertion torque > 50 Ncm; and (4) sufficient interarch space to allow for restoration with anatomically sized crowns.

**Surgical Procedure**

A thorough intraoral examination was given to each patient, and a CBCT scan was taken to enable precise evaluation of the alveolar bone anatomy at the extraction site. Study casts were mounted on an articulator, a diagnostic wax-up was made, and an acrylic resin provisional prosthesis and surgical template were fabricated.

Either 1 or 2 days before surgery, patients underwent an oral hygiene session and were instructed to use 0.20 chlorhexidine rinse three times a day for 14 days. Twelve hours before the surgery, the patient was started on antibiotic prophylaxis with 1 g amoxicillin, taking one tablet twice a day for 5 days. Local anesthesia was delivered with 4% articaine with adrenaline (1:100,000) in the vestibular and lingual areas. At all sites, the tooth was atraumatically extracted with a flapless approach. In accordance with the implant manufacturer’s protocol, the drilling sequence was followed with a slight modification: With the last drill, the diameter of the osteotomy site was underprepared to improve primary stability. This was accomplished by using a final drill that was 1.5 mm shorter than the actual implant length. The implant was placed (Co-Axis, Southern Implants), and final seating was obtained using a torque-calibrated hand-ratchet. All implants had an insertion torque of 50 Ncm or higher.

Only SCA tapered implants with an external hex connection were used in the study. The implant lengths were either 11.5, 13, or 15 mm, with a diameter of either 4 or 5 mm (Fig 1). These implants feature a platform angulation of either 12

![Fig 1 Implant distribution by diameter and length.](image-url)
degrees (five implants) or 24 degrees (five implants), negating the need for angled abutments.

**Prosthetic Workflow**

In all cases, the implant was immediately provided with a provisional restoration. Several steps were performed to create the anatomically designed restorations. Alginate (Jeltrate Fast Set, Dentsply Sirona) impressions and occlusal registrations (Ramitec, 3M ESPE) were acquired 1 week before surgery to develop study casts, which were mounted on an articulator. The shape and size of the natural tooth anatomy in the transmucosal area were fabricated to replicate the exact subgingival dimension in the provisional restorations for soft tissue support; acrylic resin provisional restorations were fabricated as exact replicas of the original tooth with respect to the supra- and subgingival areas for an optimal esthetic result.

Temporary platform-switched abutments (titanium cylinders, Southern Implants) were placed and then joined to a provisional shell using a light-cured composite resin (Tetric EvoFlow, Ivoclar Vivadent). The occlusion was adjusted to leave the temporary prosthesis out of occlusion, with the opposing dentition both in centric relation and lateral or protrusive excursions.

The buccal area was grafted with bone substitute (Endobon, Zimmer Biomet), and a resorbable membrane (OsseoGuard Flex, Zimmer Biomet) was placed as a barrier to contain the graft. A connective tissue graft was inserted to cover the membrane and to correct the soft tissue deficiency. A subepithelial connective tissue graft harvested from the palate was then anchored on the inner aspect of the buccal gingival tissue using a resorbable suture (6-0 PDS monofilament, Ethicon). The particulate graft consisted of bovine xenograft particulate material (0.5 to 1.0 mm; Endobon, Zimmer Biomet). It was inserted in the buccal and interproximal areas of the alveolar bone. The screw-retained provisional prosthesis was placed and torqued to 20 Ncm for the final seating, following the manufacturer’s protocol, with a calibrated torque hand-ratchet.

Figures 2 and 3 show the clinical procedures of two cases.

Patients were instructed to stay on an exclusively liquid diet for the first week and to refrain from chewing on the implant crown for 3 months. Smoking patients were instructed not to smoke for a minimum of 4 weeks. All patients returned weekly throughout the first postsurgical month for examination and hygiene maintenance, and once monthly thereafter.

After 6 months, a final impression was made using a custom tray, a pick-up coping (Southern Implants) that was customized to replicate the transmucosal area of the provisional restoration, and a low-viscosity polyether material (Impregum Penta, 3M ESPE). A gold UCLA abutment (GUCA, Zimmer Biomet) was used for all cases. Final restorations were screw-retained, and the abutments were torqued to 35 Ncm with a calibrated torque controller (Torq Control, Anthogyr) following the manufacturer’s recommended prosthetic protocol.

**Data Collection**

Follow-up measurements were taken at each consecutive 6-month follow-up. Survival rate was measured using definitive restoration as the baseline. All complications and adverse events were recorded.

CBCT analysis and horizontal and vertical bone dimension records were conducted preoperatively and at the 1- to 3-year follow-up. The original height of the alveolar deficiency was measured.

Changes in the mesial and distal crestal bone levels were measured from periapical radiographs and averaged to determine marginal bone loss (MBL) using the VixWin Platinum software (Gendex).

Preoperative midfacial soft tissue recession, probing depth, and distance from the gingival margin to the alveolar crest are listed in Table 1.

Soft tissue levels and the mesial and distal MBL were measured immediately postoperatively, at 6 months, and at the 1-year follow-up.

In order to evaluate the esthetic result, an independent operator conducted pink esthetic score (PES) measurements using an optical loupe (×2 magnification; EyeMag Pro S, Zeiss). Seven variables were evaluated and compared to a natural reference tooth: mesial papilla, distal papilla, alveolar process de-
efficiency, and soft tissue level, contour, color, and texture. The variables were assessed using a 0-1-2 scoring system (with 0 as the worst score and 2 as the best score), and the highest achievable PES was 14.

Results
A total of 10 patients (2 men and 8 women; 7 nonsmokers and 3 smokers) each received one implant. The tooth sites comprised three maxillary central incisors, three maxillary lateral incisors, and four maxillary canines. Figure 1 shows implant distribution by diameter and length.

All 10 cases were Type III sockets, according to the

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classification proposed by Elian et al.10 No implant failed, and the survival and success rates of restorations were both 100%. Limited MBL (mean: 0.43 ± 0.23 mm) was observed.

The tissue level at 1 year postoperative showed a mean coronal gingival level gain of 1.6 ± 1.17 mm; a mean reduction in probing depth of 4.35 ± 1.88 mm; a mean vertical alveolar bone gain of 4.0 ± 1.5 mm; and a mean facial bone thickness (measured at the implant collar) of 2.0 ± 0.6 mm.

All implants met the success criteria of ≤ 1.5 mm bone loss in the first year and 0.2 mm each year.

Fig 3 Case 2. (a) Preoperative facial and (b) CBCT views of a left central incisor, showing severe facial tissue recession and complete alveolar deficiency. (c) A Co-Axis implant was placed. (d) A subepithelial connective tissue graft was placed with (e) a resorbable membrane to contain the graft. (f) Occlusal view of the implant with particulate graft material, membrane, and connective tissue graft in situ. (g) Immediate postoperative clinical and (h) periapical radiographic views of the immediately placed screw-retained provisional restoration. (i) Clinical, (j) periapical radiographic, and (k) CBCT views at the 3-year follow-up, showing complete soft and hard tissue regeneration.
Table 1 Preoperative Soft and Hard Tissue Levels

<table>
<thead>
<tr>
<th>Patient</th>
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<td>1 mm</td>
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Table 2 Pink Esthetic Score (PES) for Each Patient at the Final Follow-up

<table>
<thead>
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<td>10</td>
<td>12</td>
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</table>

The seven variables were evaluated and compared to a natural reference tooth and were assessed using a 0-1-2 scoring system (0 as the worst score, 2 as the best score). The highest achievable PES was 14.

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thereafter, as originally proposed by Albrektsson et al.11

The average PES was 12.5 (range: 11 to 14). Table 2 shows detailed PES values for each implant restoration at 2 to 5 years of follow-up (mean: 3.5 years).

Only one complication resulted after 2 years: A prosthetic screw was loosened, which was resolved by retightening. No other adverse events were identified.

Discussion

The aim of this observational study was to show outcomes of SCA implants used to replace hopeless single teeth with bone and soft tissue deficiencies in the anterior maxilla, concurrent with bone and soft tissue grafting and immediate loading. All 10 implant cases were successful, which is in line with similar studies on immediate placement and loading in the esthetic zone.12-17
The immediate placement and loading approach can significantly reduce treatment time and patient discomfort, and in some cases has been associated with less bone resorption compared to delayed placement and delayed loading. Studies on the same SCA implant used in the present study have demonstrated success rates of 100% over 5 years, although these sites had intact facial bone at extraction.

Due to the morphology of the anterior maxillary alveolus, the ideal implant axis is frequently offset from the prosthetic axis, resulting in the screw access hole penetrating the facial aspect of the crown. This is even more frequent in cases where the alveolar facial plate is severely compromised or completely missing, as in all of the present cases.

Several techniques are used to overcome this angular deviation, such as: (1) cementing the crown to negate the screw channel; (2) using angulated abutments; (3) variations in three-dimensional implant positioning; and (4) using implants with a subcrestal angular correction to align the prosthetic platform with the occlusal plane.

Compared to screw-retained crowns, crown cementation has repeatedly been associated with increased occurrences of biologic complications due to residual cement interfering with peri-implant tissues. The use of angled abutments solves screw-channel misalignment but places undue strain on the prosthetic screw. Some studies have suggested that the oblique loads transferred by angled abutments may present a risk for peri-implant bone loss.

Correct and optimal three-dimensional implant positioning is critical (ie, as palatal from the buccal wall as possible, placed 1 to 2 mm subcrestally, and at an apical angle conducive to using the maximum amount of native bone). Failure to meet these criteria can result in facial bone resorption and even implant failure. SCA implants seem to resolve all of the aforementioned difficulties and, when the buccal bone is compromised, allow for engagement of the palatal bone to achieve adequate implant primary stability, which is a prerequisite to immediate loading.

Ma et al published results of a prospective study on single SCA implants placed immediately after extraction in the esthetic zone. At the 5-year follow-up, 100% of implants were successful. Between the 1-year and 5-year assessments, patients lost an average of 0.1 ± 0.57 mm of marginal bone, and midbuccal mucosal levels receded by a mean of 0.08 ± 0.42 mm from baseline values.

Chu et al studied the outcomes of ridge dimension stability and peri-implant soft tissue thickness when comparing SCA implants to conventional tapered implants. Comparison of the buccolingual ridge width to its contralateral tooth showed that the SCA group gained an average of 0.35 mm, while the straight implant group lost an average of 0.04 mm. Midfacial labiopalatal soft tissue thickness was compared to the contralateral tooth and showed a greater increase for SCA implants (mean 3.12 mm) compared to the straight implant group (mean 2.39 mm).

The use of xenograft in this study is supported by a recent evidence-based review showing equal or higher success and survival rates of xenograft (100% for both) compared to block grafts (91.5% and 75%, respectively); blood derivatives (91.5% and 96.7%, respectively); composite grafts (80.9% and 94.2%, respectively); and particulate grafts (100% for both).

Abutments should provide adequate support and retention of the prosthesis on the implant for as long as possible, without compromising esthetics or inducing biologic or mechanical complications. The temporary abutments used in the present study were titanium cylinders, and gold cylinders were used for definitive restorations. The chimneys of the abutments were textured, although this feature can be ignored, as its function is to enhance cement retention, but all of the present restorations were screw-retained. All implants had an external hex connection.

A review of the effect of emergence angle and emergence profile on peri-implantitis and peri-implant mucositis showed weak evidence that more severe angulations and concave profiles may lead to a higher incidence of these conditions, but there was no influence of material, favoring the straight, cylindrical abutments used in the present study. A 4-year prospective comparison between the soft tissue parameters of gold and titanium abutments in single anterior teeth found no significant advantage of
one material over another.\textsuperscript{30} A meta-analysis comparing external, internal flat-to-flat, and conical implant abutment connections found that conical connections showed lower rates of marginal bone loss and prosthetic (mechanical) complications than internal flat and external connections; however, no differences were found between connections for implant survival and biologic complications.\textsuperscript{31} The SCA implants used in the present study required an external hex connection; the results should be validated for different connection systems in future studies. One instance of screw loosening was observed in the present study, which wasatraumatically resolved by retightening. A benchtop study found that SAC implants resisted screw loosening significantly more than their straight counterparts because of the reduced angle of abutment screw loading.\textsuperscript{32}

Platform switching has been shown to reduce postrestoration bone remodeling.\textsuperscript{33,34} In the present study, the platform switch used in the prosthetic components may have played a relevant role in the limited amount of marginal bone loss recorded.

The high mean PES of 12.5 (range: 11 to 14) is considered as good, according to the definition by Fürhauser et al.\textsuperscript{35}

The advantages of simultaneous placement and grafting are the generation of facial bone wall volume and the creation of a structure for regrowing the receded soft tissue.\textsuperscript{36} However, grafting has often been linked to morbidity, and graft failure may lead to failure of the implant treatment as a whole.\textsuperscript{37} The use of bovine xenograft in this study was chosen for its proven effectiveness at maintaining long-term ridge volume stability and its low morbidity rate.\textsuperscript{38}

A recent systematic review of prosthodontic maintenance/complication issues in implant fixed prostheses showed that the most common ongoing issue of single-implant crowns was screw loosening.\textsuperscript{39} In the present study, one incidence of screw loosening occurred 2 years after definitive restoration placement and was resolved by tightening, without further intervention.

The present authors believe that use of SCA implants with a flapless procedure, particulate graft stabilization with a membrane, the connective tissue graft, soft tissue supported by the natural emergence profile of the provisional restoration, and adequate primary stability were all key factors in the success of these cases.

Further research on larger patient cohorts is recommended to observe long-term outcomes of this technique and the individual contributions of the above factors.

Conclusions

Within the limitations of the study, the results show that flapless immediate implant rehabilitation in compromised alveolar sites can be a viable option to avoid multiple invasive surgical procedures and minimize treatment time, even in the challenging esthetic area. In these 10 cases, all implants were placed in sites with hard and soft tissue defects and immediately loaded; the implants integrated successfully, did not show any adverse signs or symptoms at follow-up visits, and resulted in an ideal esthetic outcome. Longer follow-ups and larger sample sizes are needed to confirm this treatment option.

Acknowledgments

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References


