Esthetic evaluation of periimplant soft tissue of immediate single-implant placement and provisionalization in the anterior maxilla

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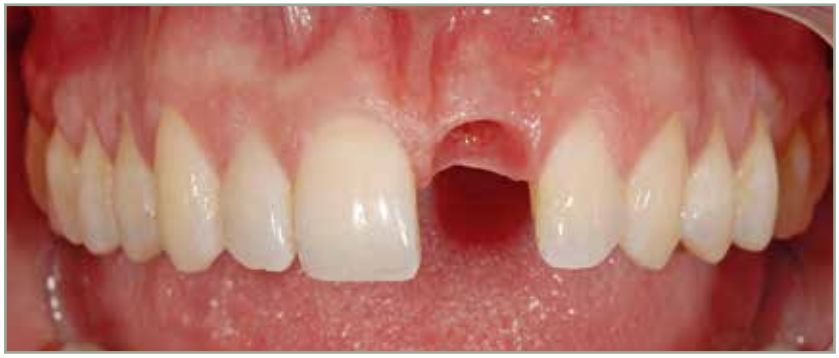

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Abstract

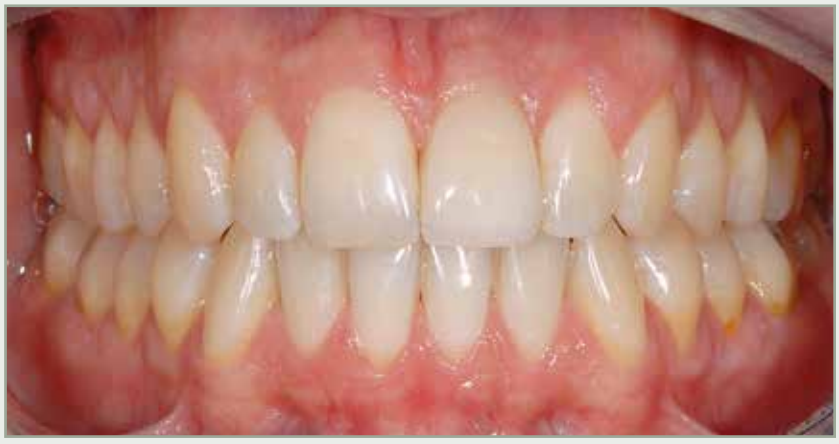
Purpose: To investigate periimplant soft tissue response following flapless extraction and immediate implant placement and provisionalization (IIPP) associated with bovine hydroxyapatite bone and connective tissue grafting in the anterior maxilla. The study evaluated the effectiveness of this technique in terms of soft tissue contours in esthetic areas with the use of the pink esthetic score (PES).

Materials and methods: In this retrospective study, 39 consecutive patients were treated and followed by two experienced clinicians for single-tooth implant treatment in the esthetic zone. Treatment consisted of flapless extraction, immediate implant placement, inorganic bovine bone filling of the periimplant gap, and connective tissue grafting. A provisional crown was placed at the time of implant placement. The final crown was positioned 5 to 8 months after surgery. To assess the esthetic outcome of the technique, the soft tissue around the tooth to be extracted was scored according to the PES by seven evaluators before the surgery at visit 1 (v1), and at least 1 year after the final prosthesis placement at visit 2 (v2).

Results: After a mean follow-up of 4 years, the mean total PES score on a scale from 1 to 10 was 5.64 and 7.07 at v1 and v2, respectively. Statistical analysis revealed a significant difference between the PES scores before surgery and at the follow-up examination of the anterior single implants ($P = 0.0008$).

Conclusion: Within the limitations of this study, postextraction with immediate implant loading associated with bovine hydroxyapatite and connective tissue grafting is a predictable technique. The esthetic outcome is that soft tissue seems to be maintained or improved significantly according to PES assessment compared with baseline.

(Int J Esthet Dent 2018;13:378–392)



Introduction

Implant placement in the anterior region has gained in popularity since the technique was first used.[1] Many studies have reported similar implant survival and success rates for implants inserted in the esthetic zone compared with those placed in other jaw segments.[2-5] In the anterior maxilla, osseointegration alone is not sufficient; patient satisfaction is a key factor in the success of implant therapy.[6]

The criteria outlined by Albrektsson et al[7] are widely used in clinical studies as a guide for analyzing the success rate of implant surgery.[7] Smith and Zarb[8] extended these criteria by indicating that a successful implant must have an adequate esthetic appearance. The esthetic outcome is determined by healthy and stable periimplant tissue as well as the final implant crown.

Fig 1 Preoperative facial view of maxillary central incisors.

Fig 2 Preoperative facial view and clinical evaluation to assess the PES at v1.

In 2005, Fürhauser et al[9] proposed an index known as the pink esthetic score (PES), which focuses essentially on the soft tissue aspects of an anterior implant restoration. The PES analyzes seven variables: mesial papilla, distal papilla, soft tissue level, soft tissue contour, alveolar process deficiency, soft tissue color, and soft tissue texture. These authors also proposed that the PES was a useful technique for reproducibility, as it evaluates the soft tissue around single-tooth implant crowns that might change over time. It can therefore be a useful tool for monitoring long-term soft tissue alterations. Belser et al[10] modified the previously published PES. These authors added a white esthetic score (WES), and proposed an implant restoration index to analyze single-tooth implants. In contrast to the original PES, their PES/WES of soft tissue alone comprises five variables: mesial papilla, distal papilla, curvature of the facial mucosa, level of the facial mucosa, and root convexity/soft tissue color and texture at the facial aspect of the implant site.

Nowadays, there is a growing tendency to place implants immediately after extraction, often combined with immediate provisionalization. This is probably a result of evolving societal factors, more demanding patients, and the wish for quick results, among other reasons. Timing of implant placement and provisionalization influences periimplant soft and hard tissue, thus challenging the esthetic and patient-centered outcome.[11]

According to some studies, implant survival hardly seems to be affected by the timing of implant placement relative to tooth extraction.[12,13] Lang et al[14] evaluated only implant survival and success rates, whereas Lin et al[15] and Cosyn et al[16] observed only soft tissue recession. A systematic review of all identified variables affecting the treatment outcome of immediate implant placement and provisionalization (IIPP) is not available in the literature.

The aim of this study was to evaluate the esthetic outcome of the soft tissue around implant-supported single crowns using a five-point scale, and to assess changes after IIPP in the anterior maxilla at least 1 year after final crown placement.

Materials and methods

Patients and study protocol

Thirty-nine patients (12 males; 27 females) with a mean age of 37.6 years (range 23 to 64 years) with single-tooth implants in the anterior maxilla were selected. The patients had root fractures and untreatable caries and were treated in private practice by two different dentists between 2003 and 2012: 15 patients were treated by Dr H. Antoun, and 24 by Dr F. Bonnet. The patients underwent a complete preoperative evaluation comprising a detailed medical history as well as clinical and radiographic examinations. All patients signed a consent form.

The following information was recorded during the clinical examination: date of extraction, mesiodistal space, prosthetic space, amplitude of mouth opening, dental and periodontal status, and type of occlusion (Figs 1 and 2). The radiographic examination included a panoramic, periapical digital radiograph, and cone beam computed tomography (CBCT) imaging was performed for all patients to assess the volume of residual bone (Fig 3). Prior to surgery, the patients underwent conventional periodontal treatment. The treatment sites included 25 central incisors and 14 lateral incisors.

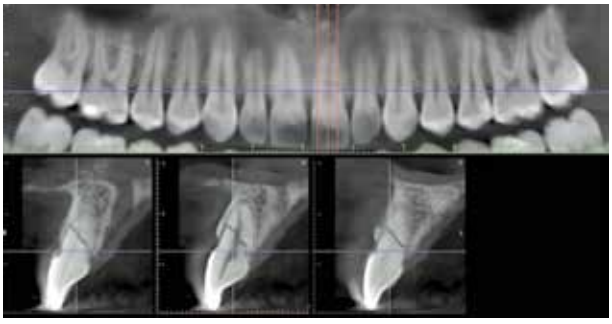


Fig 3 Preoperative CBCT scan image of tooth 21. The buccal plate was recognized.

Patients included in the study had to be at least 20 years of age or older, with acceptable oral hygiene (pink gums that did not bleed when brushing, and clean teeth free of calculus). All patients had an extraction socket with four intact walls or a maximum of 2 mm lost on the buccal plate with the presence of adjacent teeth. Exclusion criteria included patients with uncontrolled diabetes, coagulation disorders, allergies to any of the materials used in the study, acute infection with the presence of suppuration at the surgical site, and heavy smokers (more than 10 cigarettes per day).

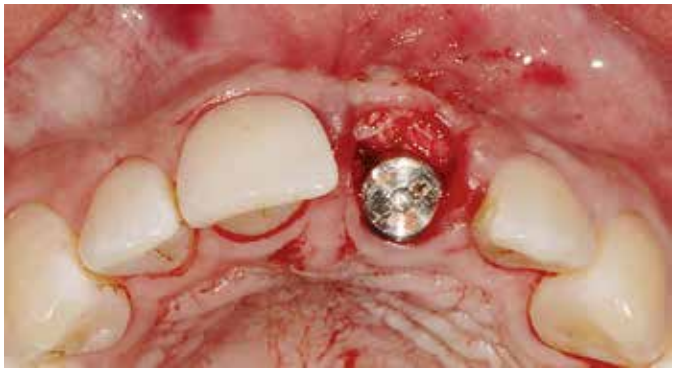


Fig 4 Occlusal view of the bone graft in the gap between the facial bone and the implant. View of connective tissue graft placement.

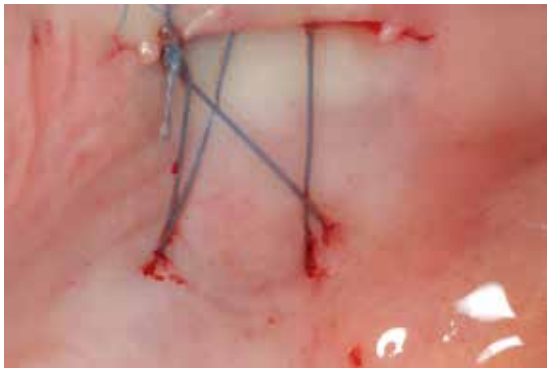


Fig 5 View of donor site after suturing.

Pharmacological treatment associated with surgical procedure

Antibiotics were administered prophylactically 1 hour prior to surgery (2 g amoxicillin; Amoxicilline Biogaran, GlaxoSmithKline) and then routinely for 7 days.[43] Patients allergic to penicillin were given 600 mg clindamycin (Dalacin 600 mg, Pfizer). Metronidazole was also given 1 h prior to surgery (1000 mg Flagyl, Sanofi-Aventis), and daily for 5 days. A dose of arnica 9CH was given the night before and for 2 days following surgery. Oral bromazepam (3 mg Lexomil, Roche) was given for sedation 1 h before surgery, and patients were asked to rinse with 0.12% chlorhexidine digluconate (Paroex, Sunstar) mouthwash for 1 min immediately before surgery. Patients were instructed to continue rinsing with chlorhexidine thrice daily for 2 weeks postoperatively. Implant surgery was performed under local anesthesia with articaine hydrochloride 4% and an adrenaline 1/100,000 injection (Septanest, Septodont).

Surgical protocol

All patients underwent extraction with preservation of the buccal plate, followed by IIPP. Teeth were electively sectioned with rotary instruments and extraction was realized using periotomes in order to minimize trauma on the soft tissue and alveolar bone. Sockets were rinsed with iodine and debrided with hand instruments and burs to remove any residual granulation tissue. A total of 39 implants (NobelReplace/NobelActive, Nobel Biocare) were placed according to the manufacturer's instructions, engaging the palatal wall and the native bone above the alveolus. The platform was positioned 3 to 4 mm apically to the gingival margin

Remaining gaps between the implant and the surrounding bone were filled with Bio-Oss (Geistlich) granules. During the initial osteotomy, bone quality was assessed according to resistance while drilling with a 2-mm twist drill. Bone was classified as D1, D2, D3, or D4. Final insertion torque was measured from 30 to 70 Ncm. Implants that did not achieve

an insertion torque ≥ 30 Ncm were excluded from the study (Fig 4).

Concerning the donor site of the connective tissue, a single-incision technique was carried out with a palatal horizontal incision along the row of teeth starting from the mesial border of the first molar to the first premolar, 2 mm apical to the gingival margin, 1- to 1.5-mm deep. All the remaining incisions were made below the mucosal surface. Thereafter, the size of the graft was defined by executing two horizontal and two vertical incisions inside the created envelope. These incisions may be extended to the bone and overlap at the intersections (Fig 5). An additional incision could be made above the periosteum by sharp dissection with a scalpel blade. Finally, the connective tissue graft was immediately placed into the recipient site after a tunneling procedure and sutured with 6-0 nonresorbable monofilament sutures (Surgipro, Covidien).

Fig 6 Connective tissue graft drawn into prepared envelope with the aid of nonresorbable monofilament sutures.

Fig 7 Facial view of the provisional restoration immediately after surgery.

Prosthetic protocol

Temporary crowns

Crowns were constructed over a titanium temporary abutment using photopolymerized injectable composite (Rest Automix, Elsodont) or an autopolymerized acrylic resin (Unifast). Medical-grade Vaseline (Vaseline officinale, Cooper) was applied over the sutures (Fig 6).

The occlusion was checked, and care was taken to avoid any tooth contact in static and dynamic occlusion. After complete polymerization, the crown and the temporary abutment (forming a single entity) were removed and placed on the implant replica. Composite or acrylic resin was used to achieve properly sealed margins between the abutment and the crown, and to establish a proper emergence profile (concave on the buccal side, and not compressive).

The screw-retained provisional restoration was meticulously polished with acrylic abrasives and was not removed during the healing period to prevent any manipulation that could compromise osseointegration (Fig 7).

Patients maintained a liquid diet for 2 days postoperatively followed by a soft diet for 8 weeks.

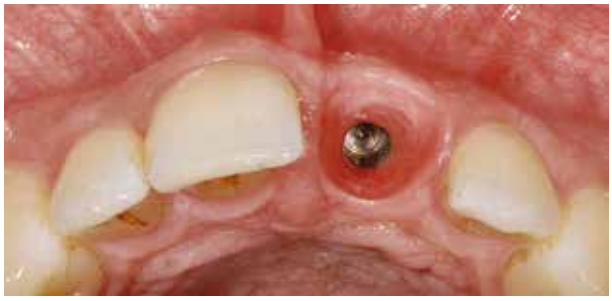


Fig 8 Implant site before pickup impression. No signs of inflammation are detectable.

Fig 9 View of the custom impression transfer.

Final crown

The definitive ceramic crown was delivered 5 to 8 months after surgery. Based on restorative preferences, the definitive crown was either cemented or screw-retained (Figs 8 and 9).

The main types of crown materials used were either ceramic fused to metal or metal-free prostheses such as zirconium crowns.

For the screw-retained method, the crown was placed in chlorhexidine mouthwash for 2 min for sanitization, then placed onto the implant and screwed into place with a manual screwdriver.

For the cemented crown method, a retraction cord was placed around the abutment. Prior to cementing, the screw access hole of the abutment was occluded with Fermit (3M ESPE). A thin layer of polycarboxylate was applied on the crown, away from the cervical margins. The crown was seated onto the abutment with finger pressure rather than occlusal pressure.

Excess cement was eliminated prior to complete polymerization, and the retraction cord removed. Further cleaning of the cement margins was accomplished with an explorer No. 23 (Hu-Friedy) and dental floss. The occlusion was checked, and the complete seating of the crown confirmed with a radiograph.

After the adjustment of the contour and the occlusion for screw-retained restorations, a silicon plug was placed into the screw access channel. The remainder of the channel was filled with a temporary filling.

Screwing the restoration may cause pressure on the periimplant mucosa, which may result in short-term ischemia of the soft tissue.

Outcome measures

The patients were recalled at 10 days, 6 months, and 12 months after surgery to assess the periimplant marginal bone level, biologic or prosthetic complications, or implant failure (any mobility or infection that required implant removal). The Albrektsson et al[7] criteria were applied to assess the outcome. Radiographs were taken subsequent to implant insertion, and postoperatively at 6 and 12 months.

Each single-tooth implant was photographed with a digital camera (D500, Canon Medical Objective 105 mm, Ôta Corporation). For assessing the anterior tooth replacements, the reference tooth

had to be sufficiently visible to ensure comparability. Photographs were taken at, or slightly superior to, the occlusal plane, centered at the contact region. The implant-supported restorations in the region of the incisors were compared to the contralateral tooth.

The photographs were magnified and projected as a presentation using Keynote. The implant-supported crowns were marked by arrows. For the PES scoring assessment, seven individuals from various specializations (prosthodontists, periodontists, and oral surgeons) completed a questionnaire.

The modified PES (Belser et al[10]) was used. Each of the five variables (see earlier, and also Fig 10) was assessed with a 2-1-0 score, with 2 being the best and 0 being the poorest score. The mesial and distal papillae were evaluated for complete presence, incompleteness, or absence. All other variables were assessed by comparison with a reference tooth, ie, the corresponding tooth (anterior region). The highest possible score reflecting a perfect match of the periimplant soft tissue with that of the reference tooth was 10 (Figs 11 to 13).

Fig 10 Guide for using the PES based on virtual presentation of an optimal single-tooth implant restoration. The five variables are: mesial papilla, distal papilla, curvature of the facial mucosa, level of the facial mucosa, and root convexity/soft tissue color and texture.

Fig 11 View of the papilla between the maxillary central incisors.

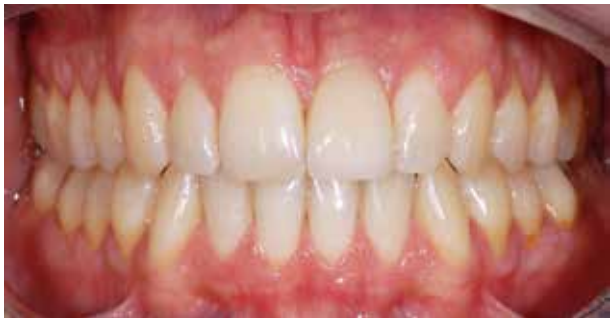


Fig 12 Facial view 1 year after crown placement to assess the PES at v2.

Fig 13 Postoperative smile view.

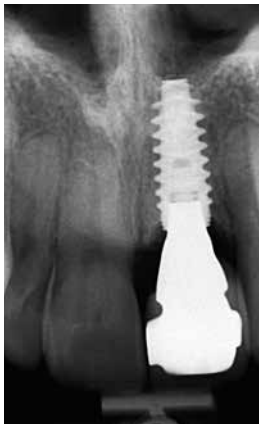


Fig 14 Periapical radiograph after 24-month follow-up. Marginal bone is stable.

The PES before the surgery at visit 1 (v1) were evaluated by the same individuals, and for the final study the scores at v1 were compared with those at visit 2 (v2) to assess the difference.

Every 12 months, periapical digital radiographs of all the patients were obtained to compare bone changes after loading with the baseline measurements (Fig 14).

Statistical analysis

Statistical analysis of the data was performed with SPSS for Windows (Version 22). The risk error was set at $P \leq 0.05$. The outcome variables of the study were the PES. The measurement reproducibility of the PES between evaluators was assessed using the intraclass correlation coefficients (ICCs) with a 95% confidence interval (CI). The Kolmogorov-Smirnov test was performed to assess the normality distributions of the scores. The Wilcoxon and Paired Student *t* tests were used to compare the scores before surgery and at a minimum of 1 year after final implant placement.

Results

Of the 39 implants, 11 replaced the right and 14 replaced the left central incisor, while 8 replaced the right and 6 replaced the left lateral incisor. All implants showed osseointegration without complications.

The ICC for PES was 0.891 preoperatively ($P < 0.001$) and 0.895 postoperatively ($P < 0.001$) (Tables 1 and 2).

The ICC for each component of PES varied between 0.739 and 0.918 (Table 3). The average measurement of each score was obtained for statistical analysis.

The mean and standard deviation (SD) of PES and each PES component are shown in Table 4. The mean PES significantly increased (by 25%) after final prosthesis placement ($P < 0.001$). No significant difference was found after surgery for the score of mesial ($P = 0.945$) and distal ($P = 0.933$) papillae. Significant enhancement was found for the level of facial mucosa ($P = 0.022$), for the curvature of facial mucosa ($P < 0.001$), and soft tissue color and texture ($P < 0.001$).

Discussion

The implant survival rate for the IIPP procedure in this study was 100% after a mean follow-up period of 4 years. Similar success rates (93.5% to 100%) have been reported for short-term studies (1 to 2 years) when single implants were immediately placed in extraction sites and provisionalized in the anterior maxilla.[17,18]

Implant success rates have also been reported when single implants placed

Table 1 Reproducibility of PES between evaluators at v1

Preoperative	Mean PES	Standard deviation	N	ICC with 95% CI
E1	4.77	1.912	39	
E2	6.10	1.875	39	0.891
E3	5.62	1.815	39	[0.830–0.936]
E4	6.15	2.146	39	
E5	5.87	1.704	39	
E6	5.26	1.773	39	
E7	5.79	1.525	39	

ICC: intraclass correlation coefficient; CI: confidence interval; E: evaluator

Table 2 Reproducibility of PES between evaluators at v2

Postoperative	Mean PES	SD	N	ICC with 95% CI
E1	7.00	1.762	39	
E2	7.13	1.735	39	0.895
E3	6.77	1.677	39	[0.836–0.939]
E4	7.51	1.730	39	
E5	6.28	1.685	39	
E6	6.95	1.605	39	
E7	7.85	1.663	39	

Table 3 Reproducibility of each PES component between evaluators

	N	ICC with 95% CI
Mesial papilla at v1	39	0.854 [0.771–0.994]
Mesial papilla at v2	39	0.847 [0.760–0.910]
Distal papilla at v1	39	0.918 [0.872–0.952]
Distal papilla at v2	39	0.876 [0.805–0.927]
Level of FM at v1	39	0.834 [0.741–0.903]
Level of FM at v2	39	0.802 [0.690-0.884]
Curvature of FM at v1	39	0.739 [0.692–0.847]
Curvature of FM at v2	39	0.851 [0.767–0.913]
Color and texture at v1	39	0.875 [0.805–0.927]
Color and texture at v2	39	0.800 [0.687–0.883]
PES v1	39	0.891 [0.836–0.936]
PES v2	39	0.895 [0.836–0.939]

FM: facial mucosa

Table 4 Mean PES component within time

	N	Mean	Standard deviation	P
Mesial papilla at v1	39	1.374	0.4115	0.945
Mesial papilla at v2	39	1.370	0.3645	
Distal papilla at v1	39	1.289	0.4954	0.933
Distal papilla at v2	39	1.286	0.4027	
Level of FM at v1	39	1.289	0.4789	0.022
Level of FM at v1	39	1.546	0.4012	
Curvature of FM at v1	39	.960	0.4372	< 0.001
Curvature of FM at v2	39	1.527	0.4660	
Color and texture at v1	39	.747	0.5459	< 0.001
Color and texture at v2	39	1.341	0.4205	
PES v1	39	5.65	1.424	< 0.001
PES v2	39	7.07	1.328	

FM: facial mucosa

in healed sites were either immediately provisionalized (100%)[19,20] or treated with a traditional delayed loading approach (97%).[21,22] It seems that IIPP does not affect implant success when primary stability is achieved during surgery and the provisional restoration is adjusted with non-occlusal contacts.

To minimize papillae loss, tooth extraction must be nontraumatic.[23,24] Papillae levels in the anterior single implant are guided by the proximal bone of the adjacent teeth to an appropriate interproximal embrasure form.[25,26] Studies recommend that papilla-saving incisions could decrease interproximal bone loss, thereby decreasing papilla loss.[27,28]

In the case of immediate anterior implant placement, a gap is present between the implant and the facial bony wall of the socket.[29,30]

It has been demonstrated that, after immediate implant placement in an anterior tooth socket, the facial bony plate undergoes remodeling characterized by bone fill from the inside of the socket, and resorption of the labial bony plate from the outside.[31] Without bone grafting, this results in significant horizontal and vertical facial bone loss and subsequent facial gingival tissue loss.[31-35]

To reduce the risk of soft tissue recession, a number of requirements have been described.[36] When immediate implant placement is indicated, a detailed examination before surgery should be carried out to achieve and maintain satisfactory esthetic implant-placement outcomes. Recent studies have focused on the midfacial mucosa level following single-implant treatment,[37,38] with contrasting data: Chen and Buser[39] reported an increased risk of advanced midfacial recession of > 1 mm, whereas other authors[40] reported a limited risk,

with midfacial gingival recession varying between 0.55 and 0.75 mm.

A study by Cooper et al[41] showed that minor changes in the mesial (0.13 ± 1.61 mm) and distal (0.21 ± 1.61 mm) papillae can occur when there is no connective tissue graft, and after immediate implant placement at the 5-year follow-up. In fact, minor apical movement of the mucosal zenith position was observed from the time of definitive crown placement until the 5-year follow-up (0.05 ± 0.92 mm).

At the 3-year follow-up, Cosyn et al[11] showed a mean loss of the mesial papillae of only 0.05 mm from the preoperative status until the end of the study. A similar trend was found for the distal papillae, resulting in a final mean loss of 0.08 mm. From the preoperative status until 3 years, there was a mean recession of 0.34 mm.

As suggested by De Rouck et al,[42] it seems that immediate stabilization of the soft tissue after tooth removal by means of immediate implant placement and temporization reveals more soft tissue preservation mid-facially compared to a delayed strategy. In this study, the level of the facial gingival margin had improved, which justifies the advantages of this approach.

Results of the present study revealed an improvement of the level, curvature, and color of the facial gingiva. There seems to be a strong correlation between the final aspect of the soft tissue and the starting point: when the starting point is favorable, favorable esthetics may be expected from an implant-based single-tooth replacement, whereas an unfavorable starting point may lead to unsatisfactory results (see Figs 2 and 12). Given the complexity of this aspect on the treatment outcome, a thorough systematic review comparing the risk of advanced midfacial recession between immediate/early and conventional single-implant treatment would be valuable.

Few case studies have been published documenting the esthetic characteristics of single-implant crowns using objective parameters.[10,38,42] Most of these studies report that optimal esthetics seem difficult to achieve, regardless of the fact that the patient is selected according to strict criteria and is treated by experienced clinicians. Careful case selection coupled with clinical experience and appropriate surgical and restorative procedures, as well as implant design and surface, are considered to be of crucial importance.

Immediate loading of single-tooth implants placed in fresh extraction sockets is suggested only in the case of optimal primary stability (> 30 Ncm).[36] In this study, all implants were tapered and inserted with a final torque of > 30 Ncm. All implant sites were characterized by favorable anatomic conditions. Implant surfaces, a flapless technique, and temporary crowns without occlusal contacts are other factors that may help to achieve success with the IIPP protocol.

The limitations of this study were the number of implants and the retrospective study design. More prospective studies are needed monitoring soft tissue dynamics over longer time periods and encompassing a larger number of implants. Within the limitations of the present study, results show that early restoration of single-tooth implants placed in fresh extraction sockets in

periodontically healthy patients may be considered a predictable procedure in terms of implant survival and soft tissue remodeling.

Conclusion

The results of this study revealed that, from an esthetic point of view, maxillary anterior single-tooth replacement in periodontically healthy patients according to the concept of IIPP seems to be a successful and predictable treatment modality. Prospective clinical trials are needed to further validate and refine this finding.

Acknowledgment

The authors would like to thank first name? Fistes for her assistance with the images.

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