Immediate implant placement and restoration in the anterior maxilla using flapless surgery and simultaneous hard tissue augmentation: Tissue dimensional changes after 2 to 5 year follow up

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Complete List of Authors: Arora, Himanshu; Griffith University, School of Dentistry and Oral Health
Khzam, Nabil; Private Practice
Roberts, David; Private Practice
Bruce, William; Private Practice
Ivanovski, Saso; Griffith University, School of Dentistry and Oral Health

Keywords: bone grafting, bone-implant interface, extraction socket, flapless implant surgery, immediate implants, immediate placement, single-tooth implants

Abstract: Background: Immediate implant placement followed by an immediate restoration has proven to be a viable technique in the anterior maxillary region.

Purpose: This prospective study evaluated the long term (2-5 years) tissue changes around immediately placed restored implants in the anterior maxilla using flapless surgery and simultaneous hard tissue augmentation.

Materials and methods: Thirty AstraTech implants were immediately placed in 30 patients, followed by the delivery of an immediate provisional restoration on the same day. All participating patients underwent the same treatment strategy that involved flapless removal of a failing maxillary anterior tooth, immediate implant placement, simultaneous augmentation with a deproteinized particulate xenograft and connection of a screw-retained provisional restoration. Radiographs and photographs were used to measure hard and soft tissue changes. Aesthetic evaluation was performed using the Pink esthetic score (PES).

Results: All implants remained osseointegrated during the follow up period of 2-5 years (mean 47 ± 15 months). Radiographic evaluation revealed average gains in bone levels of 0.18 mm and 0.34 mm mesially and distally, respectively. Soft tissue evaluation showed a mean tissue loss of 0.05 ± 0.64 mm and 0.16 ± 0.63 mm at the mesial and distal papillae respectively, while mid-facial mucosal recession was 0.29 ± 0.74 mm. A significant improvement in the Pink esthetic scores was seen at the final follow-up (mean PES 11.50), as compared to the baseline (mean PES 10.27) (p = 0.001).

Conclusions: In addition to a favourable implant success rate and peri-implant bony response, the soft tissue levels and overall aesthetics around
single immediately placed and restored implants can also be maintained in the long term. Careful case selection, appropriate three-dimensional implant positioning, the use of an implant system that minimizes marginal bone loss, flapless surgery and the use of simultaneous particulate grafting may be important factors in achieving favourable outcomes.
Title: Immediate implant placement and restoration in the anterior maxilla using flapless surgery and simultaneous hard tissue augmentation: Tissue dimensional changes after 2 to 5 year follow up

Himanshu Arora, MDS*; Nabil Khzam, DClindent †; David Roberts, MDSc ‡; William L Bruce, MDSc ‡; Saso Ivanovski, MDSc, PhD*

*: School of Dentistry and Oral Health, Griffith University, Gold Coast, QLD, Australia
†: Private practice, Perth, WA, Australia
‡: Private practice, Brisbane, QLD, Australia

Running Title: Tissue changes around anterior immediate implants

Author Contributions:
Himanshu Arora - Concept/Design, Data analysis/interpretation, Drafting article, Data collection, Statistics, Critical revision of article.
Nabil Khzam - Concept/Design, Data analysis/interpretation, Drafting article, Data collection.
David Roberts - Drafting article, Data collection, Critical revision of article, Approval of article.
William L Bruce - Drafting article, Data collection, Critical revision of article, Approval of article.
Saso Ivanovski - Concept/Design, Drafting article, Data collection, Critical revision of article, Approval of article.
Correspondence: Prof. Saso Ivanovski, School of Dentistry and Oral Health, Griffith Health Centre, Griffith University - Gold Coast Campus, Parklands Drive, QLD 4222, Australia.
Tel: +61 7 56780741
Fax: +61 7 5678 0708
Email: s.ivanovski@griffith.edu.au

Key Words: dental implants; osseointegration; soft tissue; aesthetics; immediate placement and restoration.
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INTRODUCTION

Implant dentistry has progressed considerably since its introduction, with modifications and enhancements being made to the surgical techniques, restorative protocols, and the implants themselves. The initial delayed loading and placement protocols have been modified to expedite the treatment process. These modified protocols (immediate placement and immediate loading) have been successfully applied in both fully and partially edentulous patients. Additionally, immediate implant placement has been combined with immediate restoration to eliminate the load free healing period. Since first reported, the immediate placement and restoration (IPR) technique has been widely recognized as a viable treatment modality with survival rates equivalent to other established protocols for partially edentulous situations.

The nature of IPR treatment makes it particularly suited to implant treatment in the anterior maxilla. Therefore, the focus has now shifted from hard tissue and osseointegration outcomes to the aesthetic and soft tissue results. This increased focus towards implant aesthetics led to the creation of various indices for evaluation of peri-implant mucosa as well as implant supported restorations. When evaluating aesthetic outcomes, pre-operative registration of aesthetic status is very important in order to assess the effect of a treatment intervention over time. Interestingly, very few studies evaluating the IPR protocol provide a baseline value of aesthetic ratings prior to tooth loss/implant placement.

Soft tissue dimensional changes around immediately placed and restored implants have been evaluated using standardized and non-standardized patient intra-oral photographs, study models, as well as prefabricated stents. Although there are a number of studies which analysed the effects of the IPR protocol on the soft tissue surrounding single implants in the maxillary anterior region, most of these have a short follow-up period. Furthermore, the
very few long-term studies that have investigated soft tissue outcomes using this protocol have reported variable results. Cooper and colleagues\textsuperscript{19} compared immediately provisionalized implants placed in healed ridges and extraction sockets in the maxillary anterior region and found no difference in hard and soft tissue parameters after a period of 5 years. On the other hand, a recent study found an aesthetic complication rate of 8/17 in well-selected patients who had been treated by experienced clinicians with the IPR protocol after 5 years,\textsuperscript{9} with the authors concluding that this treatment protocol may not be recommended in daily practice. Even-though both of the above-mentioned studies utilized different implant systems, they had strict patient selection criteria and included only low aesthetic risk patients. In wake of these findings it becomes important to analyse the long-term effects of this protocol on the peri-implant tissues.

The aim of this prospective study was to analyse the soft tissue and aesthetic changes around implants placed with the IPR protocol in the maxillary anterior region over a follow-up period of 2-5 years.

MATERIALS AND METHODS

Study design/Patient selection

This study included 30 patients who were recruited and treated for immediate single tooth implants in the maxillary anterior region at a private practice in Brisbane, Australia. Patient selection was undertaken on the basis of a specified set of inclusion and exclusion criteria.

Inclusion criteria:

1. Age at least 18 years
2. Presence of a single failing tooth in the anterior maxillary region (13-23)
3. Presence of natural teeth adjacent to the tooth being replaced
4. Adequate bone height apical to the failing tooth to allow for placement of an implant and to achieve a primary stability of at least 30 Ncm

Exclusion criteria:

1. Contraindications for routine implant therapy (untreated periodontitis, uncontrolled diabetes, medical conditions that contraindicate elective surgery)
2. Smoking > 10 cigarettes per day
3. Presence of acute infection around the tooth being replaced
4. Presence of any soft tissue pathology at the gingival margin.
5. Any fenestration or dehiscence in the socket wall of the failing tooth

Informed consent was obtained from the eligible subjects, and the study was approved by the Human Research Ethics Committee, Griffith University, Australia. The study was conducted in accordance with the Helsinki Declaration of 1975 as revised in 2000.

**Surgical and prosthetic procedures**

Following the initial screening, a comprehensive clinical and radiographic examination was undertaken by the operating surgeon. All surgical procedures were conducted by a single operator (S.I.) under local anaesthesia. A prophylactic antibiotic dose of Amoxicillin, 500 mg three times daily, was started a day before surgery and continued for 1 week. On the day of the surgery, the tooth scheduled to be replaced was removed asatraumatically as possible using perirotomes and without flap elevation. This was followed by the placement of an implant, according to the instructions of the implant manufacturer (Astra Tech®, Mölndal, Sweden). Particular care was taken during the preparation of the osteotomy to facilitate both primary stability and screw retained access, as well as to avoid impingement on the buccal socket wall. Every attempt was made to engage the palatal and apical bone to achieve a high
primary stability (30 Ncm) while placing the implant in a correct 3-dimensional position.\textsuperscript{20} In all implant sites, the gap between the implant and the inner aspect of the buccal socket wall was filled with deproteinized bovine bone particles (Bio-Oss®, Geistlich Pharma AG, Wolhusen, Switzerland) (Figure 1). Postoperative instructions included Chlorhexidine rinses twice daily, for a period of 2 weeks. For pain control Ibuprofen 400 mg was prescribed, to be used as needed.

Implant placement was immediately followed by connection of a temporary abutment onto which a prefabricated screw-retained temporary crown was placed. The provisional restoration was adjusted to ensure that it was free of any contact in both centric and eccentric positions. Patients were advised to avoid placing any pressure on the temporary crown during the healing period. After a period of 3-4 months, the provisional restoration was replaced by a permanent restoration. All prosthetic procedures were performed by two experienced prosthodontists (D.R, W.B).

**Hard tissue measurements**

Periapical radiographs were taken with a paralleling technique after implant placement (baseline) and follow-up appointments to measure the changes in the alveolar bone height surrounding the implant. The radiographs were digitized, and bone level changes were measured with the help of computer software (Image J 1.43u, NIH, Bethesda, MD, USA). Standardization was carried out using the known implant length to calibrate the baseline and follow-up radiographs. The implant shoulder was used as a reference level from which mesial and distal lines were drawn in an apical direction to the first point of contact between implant and bone, as previously described.\textsuperscript{16}
Soft tissue measurements

Intra-oral photographs were taken before extraction and implant placement (baseline) and follow-up visits to evaluate the soft tissue changes. A digital SLR camera (Cannon 1300D, Cannon Inc., Tokyo, Japan) was used to take photographs, at a fixed angle and magnification ratio. Photos were taken with a periodontal probe with standardized markings to calibrate changes in the level of soft tissues surrounding the tooth. Photographs were imported into software (Image J 1.43u, NIH, Bethesda, MD, USA) for further measurements. A line extending from the incisal edges of teeth adjacent to the implant was used as the reference point for measurements. From this line, perpendicular lines were drawn extending to the tip of the mesial papilla, distal papilla, and the mid-buccal gingival margin, as previously described. The variations in the length of these lines over time were calculated to quantify the soft tissue changes.

Aesthetic evaluation

Aesthetic evaluation was carried out using the Pink esthetic score (PES). PES is used to evaluate the peri-implant soft tissue and includes seven variables: mesial papilla, distal papilla, soft tissue level, soft tissue contour, alveolar process deficiency, soft tissue colour, and soft tissue texture. Each parameter is assessed with a 0-1-2 score with 2 being the best and 0 being the worst score. The score for each parameter is added to get the eventual PES for each case (maximum possible score being 14). All the measurements were performed by a single examiner (H. A.), who was not involved in the treatment.

Statistical analysis

Mean values and standard deviations were calculated for all parameters. Parametric data were analysed using a paired t-test; whereas for nonparametric data, a Wilcoxon signed rank test
was used. A frequency analysis was used to describe soft tissue quantitative changes. The level of significance was set at 0.05. All calculations were performed with the SPSS statistical software program (Version 16.0, SPSS Inc., Chicago, IL, USA).

Results

The study included a total of 30 OsseoSpeed™ TX implants (Astra Tech®, Mölndal, Sweden) implants, which were placed utilizing the IPR protocol in 30 patients (9 males and 21 females) with an age range of 20 to 78 years. Sixteen implants replaced central incisors, 12 replaced lateral incisors, and 2 implants were placed in the canine region. The reasons for tooth failure were recorded as fracture (21 cases), endodontic failure (7 cases), and root resorption (2 cases). Implants placed had diameters ranging from 3.5 to 5.0 mm and length ranging from 11 to 15 mm. After a mean post-operative period of 48 months (range: 2 to 5 years), all implants were stable with no loss of osseointegration resulting in a cumulative implant survival rate of 100%.

Hard tissue measurements

Bone levels around the implants showed an overall gain in bone height at the final follow up when compared to baseline. Mesial bone levels showed a mean gain of $0.18 \pm 1.38$ mm ($p = 0.85$), while distal bone levels showed a mean gain of $0.34 \pm 1.40$ mm ($p = 0.22$). Figure 2 shows the frequency analysis of bone level changes mesially and distally. Bone changes ranged from $>2$ mm mean loss (3%) to mean gains of $>2$ mm (10%) with most of the values lying (30%) between 0.5 mm loss to 0.5 mm gain (Figure 2).

Soft tissue measurements

After a follow-up period of 2 – 5 years, the mesial and distal papillae showed a mean recession of $0.05 \pm 0.64$ mm and $0.16 \pm 0.63$ mm, respectively, while mid-facial mucosal
margin showed a mean recession of 0.29 ± 0.74 mm, with no value reaching statistical significance. A frequency analysis of the soft tissue dimensional changes from baseline to the final follow-up is shown in Figure 3. Most of the changes were between 0.5 mm of tissue loss to 0.5 mm tissue gain (Figure 1). Advanced soft tissue recession (defined as >1 mm by) was identified in the mid-facial mucosa of 4 patients (13%). Further evaluation revealed that 2 of these 4 patients had no soft tissue level discrepancy when compared to the contralateral natural teeth (Figure 4).

To evaluate the effect of the IPR protocol on the soft tissue changes in the long-term, a comparison between 1 and 5-year time points was carried out. Twelve patients who had completed the 5-year follow-up and were included in this sub-analysis (Table 1). A statistically significant regrowth of 0.4mm was seen in the mesial papillae ($p = 0.009$) between 1 and 5 years. The distal papillary region also showed a gain in soft tissue levels of an average of 0.19mm but this was not statistically significant ($p = 0.225$), whereas the mid-facial mucosal recession was similar at 0.20 and 0.23 mm for 1 and 5 years, respectively ($p = 0.776$).

**Aesthetic evaluation**

Table 2 shows the results of various PES criteria preoperatively and at the final follow-up. Most of the criteria showed improvement between baseline and final follow-up. The mean PES preoperatively was 10.27 (SD 2.18; range 5-13). A significant improvement ($p = 0.001$) was seen at the final follow-up appointment, with the mean PES score reaching 11.50 (SD 1.36; range 8-13). In terms of individual PES parameters, the following variables were seen to improve significantly: soft tissue level, soft tissue contour, soft tissue colour, and soft tissue texture (Figure 5). Once again, to evaluate the effect of the IPR protocol on the aesthetic changes in the long-term, follow-up time points of 1 and 5 years were chosen (Table
1). The mean PES scores improved slightly from 11.17 at 1 year to 11.25 at 5 years ($p = 0.48$). When looking at the individual variables, most of the variables showed an improvement in the mean scores, except for soft tissue contour ($p = 0.375$) and alveolar process deficiency ($p = 0.125$) showing a slight deterioration.

Discussion

The implant survival rate in this study utilizing the IPR protocol and after a follow up period of 2 - 5 years was 100%. Comparative survival rates have also been seen in other studies utilizing the same surgical and restorative protocol in the maxillary anterior region.\textsuperscript{5, 12, 14, 22-25} The results from the current study showed a non-significant mean bone gain of 0.18 mm and 0.34 mm mesially and distally, respectively. These results are in accordance with several studies which have reported favourable bone levels with this technique,\textsuperscript{16, 18, 22, 26-29} albeit after shorter follow up periods. The present study used Astra Tech implants, with a number of features which have been shown to minimise crestal bone loss including a platform switched design, coronal micro threads and an internal conical connection.\textsuperscript{30} Similar favourable results have been reported in various shorter duration studies when using Astra Tech implants with the IPR treatment protocol.\textsuperscript{15, 18, 31-33} Furthermore, the gap between the implant and the inner walls of the extraction socket was filled with a slowly resorbing xenograft (Bio-Oss®), Geistlich Pharma AG, Wolhusen, Switzerland) in all cases. The increase in bone levels could be attributed to the filling of bone in the extraction socket, and could further have been favoured by the implant design.\textsuperscript{16, 23} The positive influence of grafting the peri-implant gap and placing an immediate provisional restoration subsequent to flapless immediate implant placement on maintaining the ridge contour dimensions has also been previously reported.\textsuperscript{34} This study observed a mean soft tissue recession of 0.29 mm in the mid-facial region and 0.16 and 0.05 mm in the mesial and distal papillary region respectively, after a follow up
period of 2 – 5 years. These results are similar to the previous studies reporting soft tissue changes around implants placed with the IPR protocol in the maxillary aesthetic region.\textsuperscript{12, 14-18, 23, 35, 36}

The number of studies reporting on advanced recession (>1 mm) around immediately placed and restored implants is very limited, especially when it comes to long term follow-ups. A 3-year follow-up study with immediately placed and restored implants showed the incidence of advanced mid-facial recession in 8% of cases (2/25 patients).\textsuperscript{21} Notably, these cases were treated with a connective tissue graft. After a follow-up of 5 years, the cases treated with the soft tissue graft maintained acceptable soft tissue levels, but the authors observed a late advanced recession in three other cases leading to a high aesthetic complication rate.\textsuperscript{9} In our study, advanced recession was seen in 13% of cases (4 patients), which is in accordance with the results from the previous studies.\textsuperscript{11} No soft tissue grafting was performed in any of the patients included in the current study. It is noteworthy that out of these 4 cases with advanced recession, 2 had no discrepancy when compared to the contralateral tooth at the final follow-up and were given a score of 2 for the respective PES parameter (Figure 3). This is an interesting finding as sometimes gingival recession can be deliberately induced by the prosthodontist to create harmony with the soft tissue level on the contralateral tooth, and this was the case in 2/4 cases that were deemed to have experienced ‘advanced’ recession.

Aesthetic evaluation was also carried out using the PES index. The mean PES scores increased significantly from 10.27 pre-operatively to 11.50 at the final follow-up. Interestingly, very few studies reporting on the IPR protocol in the anterior maxilla provide a baseline value of aesthetic ratings prior to tooth loss/implant placement.\textsuperscript{9, 10} Pre-operative registration of aesthetic status is important in order to evaluate changes over time. Significant improvements were seen in four of the seven PES variables, namely: soft tissue level, soft tissue contour, soft tissue colour and soft tissue texture. Interestingly, the contour of the
alveolar process was slightly reduced at the final follow-up as compared to the baseline (Alveolar process contour: Baseline 1.70, follow-up 1.67). This effect was also reported in a recent 3-year study on immediately provisionalized implants.\textsuperscript{10} Even though the shrinkage of the alveolar process seen in this study was very slight, this variable needs further exploration.

In regards to the long-term soft tissue changes, the mesial papillary levels showed a significant gain between 1 and 5 years. The distal papillae were also seen to improve but the difference was not significant. A slight increase in papillary dimension following an initial loss suggesting a papillary rebound has also been reported in a recent systematic review of soft tissue outcomes using the IPR technique.\textsuperscript{11} Similar results have also been reported by Cosyn and colleagues,\textsuperscript{9} who reported a significant increase in papillary height after 5-years. The slight disparity between the mesial and distal papillary growth observed in the present study has also been described in other studies, with authors mentioning about the difficulty to maintain distal papilla levels.\textsuperscript{37-39} The reasons for this observation are unclear and warrant further investigation. Interestingly, the mid-facial gingival levels were maintained between the period of 1 to 5 years in this study, which is more favourable compared to the increased recession reported by Cosyn et al.\textsuperscript{9} over the same timeframe. This could be attributed to the use of a different implant system in this study.

Aesthetic evaluation with the help of PES showed a slight increase in the mean values between 1 and 5 years ($p = 0.48$). Again, this is in contrast to the findings of Cosyn et al.\textsuperscript{9} who reported a significant decrease in the overall PES values between 1 and 5 years. The significant decrease in the PES values was observed despite improved mesial and distal papillae, with the authors pointing to soft tissue level and alveolar process deficiency as factors leading to a poor aesthetic outcome. Even though a slight negative change in the alveolar process was observed in the current study, the soft tissue level as well as the papillae were maintained at acceptable levels between 1 and 5 years. Nonetheless, the current results
should be interpreted with caution due to the small number of patients (n = 11) who completed the 5-year follow-up. In the future, it would be interesting to see more controlled studies exploring the long term clinical and aesthetic effects of the IPR protocol in the maxillary anterior region.

**Conclusion**

This prospective 2-5 year follow-up study showed that immediately placed and restored implants with a flapless technique in the maxillary anterior region yielded positive results in terms of osseointegration, hard and soft tissue results, as well as aesthetic outcomes. It should be noted that the study utilised a standardised treatment protocol using flapless surgery and augmentation of the gap between the implant and the buccal socket wall, as well as specific inclusion criteria including intact socket walls and absence of gingival pathology.

Acknowledgements: The authors declare no conflict of interest in relation to this manuscript.
Figure Legends:

Figure 1: Clinical illustration of the IPR protocol. (a) Failed maxillary left central incisor to be replaced with an implant, (b) & (c) frontal and occlusal view after flapless extraction, (d) implant placed in the socket in an appropriate 3-dimensional position, (e) buccal gap grafted with particulate bone graft, (f) implant restored with a provisional crown on the same day, (g, h, i) follow-up after 1, 2, and 3 years, respectively.

Figure 2: Bone level changes from baseline to final follow-up.

Figure 3: Frequency analysis of soft tissue changes from baseline to final follow-up.

Figure 4: Case with ‘advanced’ mid-facial recession (>1mm). (a) Pre-extraction view of maxillary right lateral incisor, (b) advanced mid-facial recession evident after definitive restoration, (c) comparison with the contralateral natural tooth reveals no discrepancy between the soft tissue levels after 1 year, (d) soft tissue levels maintained after 5 years.

Figure 5: Pink esthetic score results over the time course of the study. (a) Cumulative percent scores for baseline and final follow-up, (b) average scores for individual variables.
References


Table 1: Soft tissue and aesthetic changes between 1 and 5 years (baseline – pre-operative status)

<table>
<thead>
<tr>
<th>Soft tissue variables</th>
<th>1 year (n = 12)</th>
<th>5 years (n = 12)</th>
<th>p-value</th>
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</thead>
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<tr>
<td>Mesial papillary recession</td>
<td>0.34 ± 0.52</td>
<td>-0.06 ± 0.66</td>
<td>0.009*</td>
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<td></td>
<td>0.35 (0.05 – 0.68)</td>
<td>-0.05 (-0.43 – 0.43)</td>
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<td></td>
<td>[-0.5 – 1.3]</td>
<td>[-1.2 – 1.2]</td>
<td></td>
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<tr>
<td>Distal papillary recession</td>
<td>0.13 ± 0.47</td>
<td>0.06 ± 0.58</td>
<td>0.225</td>
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<td>0.1 (-0.2 – 0.55)</td>
<td>-0.2 (-0.48 – 0.23)</td>
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<td></td>
<td>[-0.7 – 0.8]</td>
<td>[-0.6 – 1.4]</td>
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<tr>
<td>Mid-facial recession</td>
<td>0.2 ± 0.47</td>
<td>0.23 ± 0.69</td>
<td>0.776</td>
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<td>0.1 (-0.1 – 0.58)</td>
<td>0.15 (-0.35 – 0.8)</td>
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<tr>
<td></td>
<td>[-0.5 – 1.0]</td>
<td>[-0.8 – 1.3]</td>
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<tr>
<td>PES variables</td>
<td></td>
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<tr>
<td>Mesial papilla</td>
<td>1.33 ± 0.49</td>
<td>1.58 ± 0.52</td>
<td>0.25</td>
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<td>Distal papilla</td>
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<td>Soft tissue level</td>
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<td>1.5 (1.0 – 2.0)</td>
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<td>[0.0 – 2.0]</td>
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<tr>
<td>Soft tissue contour</td>
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<td>Alveolar process deficiency</td>
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<td>1.17 ± 0.39</td>
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<td>Soft tissue colour</td>
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<td>1.91 ± 0.29</td>
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<td>2.0 (2.0 – 2.0)</td>
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<td></td>
<td>[1.0 – 2.0]</td>
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<tr>
<td>Soft tissue texture</td>
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<td>1.83 ± 0.39</td>
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<td>2.0 (1.25 – 2.0)</td>
<td>2.0 (2.0 – 2.0)</td>
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<td></td>
<td>[1.0 – 2.0]</td>
<td>[1.0 – 2.0]</td>
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<td>Overall PES</td>
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<td>11.25 ± 1.36</td>
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<td>[8.0 – 13.0]</td>
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</tr>
</tbody>
</table>

Values in bold: Mean (SD); italic: Median (IQ range); square bracket: [Minimum; maximum].

Negative values indicate increase in soft tissue level.

*Significant change between 1 and 5 years utilizing Wilcoxon signed rank test.
Table 2: PES change from baseline to final follow-up

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Score</th>
<th>Preoperative</th>
<th>Final Follow-up</th>
<th>p Value</th>
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<tbody>
<tr>
<td>Mesial papilla</td>
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<td>6</td>
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<td>22</td>
<td>24</td>
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<td>Distal papilla</td>
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<td>1</td>
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<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
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<td>2</td>
<td>25</td>
<td>28</td>
<td></td>
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<tr>
<td>Midfacial level</td>
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<td>0.03</td>
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<td>12</td>
<td>11</td>
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<tr>
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<td>15</td>
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<td>Midfacial contour</td>
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<td>13</td>
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<td>Soft tissue colour</td>
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<td>Soft tissue texture</td>
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<tr>
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<td>2</td>
<td>11</td>
<td>20</td>
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<tr>
<td>Overall PES</td>
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<td>0.001</td>
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<tr>
<td>Mean (SD) {Median (IQR)} [Range]</td>
<td>10.27 (2.13)</td>
<td>11.50 (1.36)</td>
<td></td>
<td>[11.0 (9.0 – 12.0)]</td>
</tr>
</tbody>
</table>
Figure 1: Clinical illustration of the IPR protocol. (a) Failed maxillary left central incisor to be replaced with an implant, (b) & (c) frontal and occlusal view after flapless extraction, (d) implant placed in the socket in an appropriate 3-dimensional position, (e) buccal gap grafted with particulate bone graft, (f) implant restored with a provisional crown on the same day, (g, h, i) follow-up after 1, 2, and 3 years, respectively.

Figure 1
254x190mm (96 x 96 DPI)
Figure 2: Bone level changes from baseline to final follow-up.

87x60mm (300 x 300 DPI)
Figure 3: Frequency analysis of soft tissue changes from baseline to final follow-up.
Figure 4: Case with ‘advanced’ mid-facial recession (>1mm). (a) Pre-extraction view of maxillary right lateral incisor, (b) advanced mid-facial recession evident after definitive restoration, (c) comparison with the contralateral natural tooth reveals no discrepancy between the soft tissue levels after 1 year, (d) soft tissue levels maintained after 5 years.
Figure 5: Pink esthetic score results over the time course of the study. (a) Cumulative percent scores for baseline and final follow-up, (b) average scores for individual variables.