Esthetic Outcomes for Immediate Implant Placement with Immediate Provisionalization in the Anterior Maxilla with Buccal Dehiscence: Results of a Comparative Pilot Study

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Purpose: The aim of this pilot exploratory cohort study was to assess the value of buccal augmentation in immediate implant placement and immediate restoration of anterior teeth in maxillae with missing buccal lamellar bone with regard to esthetic parameters, as well as soft and hard tissue level changes. Materials and Methods: This study compared three groups of 10 patients each with immediate implant placement and immediate restoration in the anterior maxilla: (1) patients with partially to totally missing buccal bone with simultaneous augmentation with bovine collagen (test group augmented [TGA]); (2) patients with partially to totally missing buccal bone without augmentation (test group nonaugmented [TNA]); and (3) patients with intact buccal lamellar bone (control group [CG]). The pink esthetic score (PES) and the course of the peri-implant bone level after 1, 3, and 12 months were used as assessment criteria. Results: After 12 months, the PES in the TGA was assessed as being better than it was preoperatively (mean ± SD: 8 ± 3.09 vs 9.25 ± 3.01, respectively, P = .8243), while it remained almost identical in the other two groups (TNA = 8.75 ± 2.7 vs 8.6 ± 3.3, P = .4098; CG = 10.6 ± 2.41 vs 10.6 ± 2.22, P = .7085). A significant difference among the PES values of the three groups was not observed at any point in time (preoperative: P = .118, 12 months: P = .383). In total, the TNA and CG showed an improvement in 3 out of 7 parameters of the PES after 12 months, while this was the case in 5 out of 7 parameters in the TGA. No significant difference among the three groups could be seen at any time point regarding peri-implant bone level. In the CG and TGA patients, a nonsignificant improvement in peri-implant bone level was seen after 12 months (respectively: 1.6 mm to 0.99 mm; P = .5866; 1.89 mm to 1.73 mm; P = .5866). In contrast, TNA patients showed a nonsignificant deterioration vs the postoperative situation (1.16 mm to 1.45 mm; P = .08208). Conclusion: Within the limitations of this pilot study, it can be concluded that a missing buccal lamellar bone appears to be no contraindication for immediate implant placement and immediate restoration, provided the baseline esthetic situation is accepted. As compared to the nonaugmented defect group or the group with intact lamellar bone, neither the esthetic nor the radiologic results could be improved significantly by augmentation with bovine collagen. Int J Oral Maxillofacial Implants 2022;37:508–514. doi: 10.11607/jomi.9198

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Immediate implant placement represents a viable treatment option for avoiding atrophy of the alveolar process, especially in the anterior region of the maxilla, and for achieving satisfactory esthetic results. Apart from adequate experience of the surgeon, immediate implantation requires several treatment steps, as documented by some investigations. These include palatal positioning of the implant without contact with the buccal bone, restricting bone denudation to an absolute minimum, and filling the gap between the implant and buccal alveolar bone for any gap larger than 2 mm. The presence of a buccal lamellar bone is considered as a prerequisite for a reduced implant loss rate and for esthetic success, and the presence of buccal bone defects is considered as a negative prognostic factor for postoperative esthetics in the anterior maxilla. If the lamellar bone is missing, treatment with a ridge preservation technique is recommended to correct the buccal defect by an augmentation separate from the implantation. Only limited investigations are available comparing the esthetic results of a ridge preservation technique with subsequent implantation vs the results of immediate implant placement together with an immediate restoration. After a follow-up period of 12 months, a comparative cohort study showed no significant

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Preoperative assessment regarding the presence or absence of the buccal lamellar bone was done by means of digital volume tomography (DVT; imaging mode 0.25 voxel high resolution, CBCT, Carestream). In 10 patients, immediate implant placement without any augmentation measures was performed (test group nonaugmented [TNA]), and 10 patients were also given a one-stage augmentation of the defect zone with bovine collagen (Bio-Oss Collagen, Geistlich) in addition to the immediate implant placement (test group augmented [TGA]). Group assignments were performed by randomization using envelopes that were opened by the patients immediately prior to treatment.

The two groups were compared to a randomly selected control group of 10 patients showing an intact buccal lamellar bone (CG). All other inclusion criteria had to be fulfilled for this group.

All surgical procedures were done by the same experienced implant surgeon (R.H.). Preoperatively, the patients were given a single oral antibiotic dose of 2 g amoxicillin. Following cautious and utterly careful tooth extraction, the alveolus underwent careful exocchelation without elevating the flap and under preservation of the papilla. Subsequently, the implants (Nobel Replace, Nobel Biocare) were anchored in bone, achieving a torque of > 35 Ncm. The buccal crestal margin of the implant had to be at least 3 mm below the deepest indention of the gingival margin and 3 mm palatally of the same. The implant had no direct contact with the buccal portions of the facial bone or soft tissue. Within 2 to 3 hours postoperation, an individualized ceramic abutment was fixed with 20 Ncm, and a provisional restoration with an acrylic resin crown was placed, as has been described elsewhere. The crowns had neither centric nor eccentric contact with the opposing dentition, and a gap with the thickness of a Shimstock foil (Coltène/Whaledent) with the neighboring teeth was maintained. The patients were permitted to continue their routine oral hygiene on the day of surgery using a toothbrush with soft bristles. After a healing time of 3 months, the ceramic abutment was fixed with a 30-Ncm force without separating it from the implant body. In the event of a potential regression of the peri-implant soft tissue, a readjustment of the ceramic abutment according to the mucosal profile was done using diamond abrasives followed by fabrication of a leucite glass-ceramic crown (Initial Zr-FS, GC) in full centric and eccentric guide function, retained with RelyX Unicem (3M).

Clinical evaluation comprised inspection of the peri-implant mucosa and measurement of probing depth in four different locations of the implant (labial, lingual, mesial, and distal) using a periodontal probe (Hu-Friedy). The probe was invariably introduced with light pressure into the sulcus parallel to the implant axis, and the distance...
from the mucosal margin to the probe tip was measured. The bleeding index (according to Mühlemann and Son) was also measured with the periodontal probe at the four locations of the implant in the same manner. 

Assessment of the PES was done preoperatively using digital intraoral photographs (EOS-1 DX, Canon), as well as postoperatively at months 1, 3, and 12. All measurements of the PES were taken in a blinded manner by two students in dental training, an experienced implantologist, and an experienced implant prosthodontist. Calibration was performed prior to the assessment.

Results were displayed as mean and SD scores.

The buccal defect was determined by sagittal reconstruction according to the longitudinal axis of the implant in the postoperative DVT scan, as described earlier. The distance between two verticals on the implant axis from the most crestal bone margin to the upper implant edge yielded the vertical defect of the buccal lamellar bone. In addition, the maximum size of the defect was evaluated at the transverse section and vertical to the implant axis.

The radiologic courses of the mesial and distal bone levels were evaluated using intraoral 35-mm radiographs. For measurement, Sidexis XG version 5 software (Dentsply Sirona) was used. Using the known implant diameter, a magnification factor was calibrated, and the mesial and distal bone levels were measured in relation to the height of the implant shoulder.

Statistical Analyses
The results were presented using descriptive statistics. The three patient groups were compared independently of each other using Kruskal-Wallis test, and bone height and PES changes within the individual groups by means of Friedman test.

For assessing a potential correlation between PES and bone resorption, Spearman rank correlation coefficient was determined.

$P$ values < .05 were considered significant.

RESULTS
This study included 14 male (average age: 55.4 years; TGA = 5, TNA = 6, CG = 3) and 16 female patients (average age: 54.8 years; TGA = 5, TNA = 4, CG = 7). In 12 cases, the implant position was the maxillary right central incisor (TGA = 4, TNA = 4, CG = 4), the maxillary right lateral incisor in 6 cases, the left central incisor in 7 cases (TGA = 2, TNA = 3, CG = 2), and the left lateral incisor in 5 cases (TGA = 1, TNA = 2, CG = 2).

The causes of the tooth loss included 11 cases of root fracture (TGA = 4, TNA = 4, CG = 3), 14 cases of chronic apical periodontitis, and 5 cases of trauma (TGA = 2, TNA = 1, CG = 2).

The procedure could be done as planned in all patients.

The vertical bone defect at the time of implantation was an average of 6.14 mm (minimum: 2.5 mm, maximum: 9 mm) in the TGA, and the average mesiodistal extension of the defect was 5.2 mm (minimum: 2 mm, maximum: 10 mm). For the TNA patients, the average vertical defect at the time of implantation was 4.2 mm (minimum: 2 mm, maximum: 12.1 mm), and the average mesiodistal extension of the defect was 3.82 mm (minimum: 1.5 mm, maximum: 8.3 mm).

The implants used were conical implants with lengths of 16 mm (TGA = 0, TNA = 3, CG = 5) and 13 mm (TGA = 10, TNA = 3, CG = 5) and with a diameter of 4.3 mm.

The postoperative time point was free of complications, and all implants remained in function during the entire follow-up period. Before taking the impression for the final crown, minimal reshaping of the buccal margin of the ceramic copy abutment (< 0.2 mm) had to be performed in every patient regardless of group. All clinical parameters were without any particular findings, at no time were probing depths > 3 mm measured, and in no case could BOP be provoked. Figure 1 shows the clinical course for one patient each from the TGA, TNA, and CG.

The mean PES values of the three groups were $9.12 \pm 2.88$ preoperatively and $8.79 \pm 2.78$, $9.1 \pm 2.86$, and $9.5 \pm 2.99$ after 1, 3, and 12 months, respectively ($P = .409$; Fig 2).

According to Krippendorff, an interobserver agreement for PES judgment of alpha = .86 could be reached, indicating a good conformity of the testers. At no point in time were significant differences in PES values between groups observed (Table 1), although the average PES in the CG showed a better assessment initially (TGA: $8 \pm 3.09$, TNA: $8.75 \pm 2.7$, and CG: $10.6 \pm 2.41$; $P = .118$).

The individual PES values by study group and time of follow-up are summarized in Table 2. Preoperatively, there was a significant difference in alveolar process deficiency between the TGA/TNA groups and CG ($P = .012$) and a temporary deterioration at the 3-month follow-up for soft tissue color in the TNA ($P = .048$). The overall PES values of the three groups showed no significant changes over time (TNA $P = .4098$, TGA $P = .8243$, CG $P = .7085$).

The bone level improved only in the CG (mesial: $1.36 \text{ mm} \pm 2.13$ after 1 month to $1.07 \text{ mm}$ after 12 months; distal: $1.90 \text{ mm} \pm 1.69$ after 1 month to $0.93 \text{ mm} \pm 0.74$ after 12 months). The detailed values can be found in Table 3.

No significant differences between the different groups at the respective time points were measured at any point in time (first follow-up mesial $P = .55$, distal $P = .85$; second follow-up mesial $P = .34$, distal $P = .16$;
third follow-up mesial \( P = .56 \), distal \( P = .11 \), and no significant changes in bone level were seen in any of the three groups (TGA \( P = .587 \), TNA \( P = .082 \), CG \( P = .081 \)).

Assessment regarding the correlation between PES and bone level did not show any significant correlation for any follow-up period (Table 4).

**DISCUSSION**

The present study investigated to what extent a partially or completely missing buccal lamellar bone may affect anterior teeth esthetics in the case of immediate implant placement with an immediate restoration and whether simultaneous augmentation of the buccal region with a missing lamellar bone would have an impact on esthetic and clinical parameters. This investigation used PES to validate the clinical outcome of the patient’s esthetics, scored on dental images. In a recently published consensus paper of the European Association for Osseointegration (EAO), the esthetic indices in implant dentistry were evaluated, and their reliability and validity investigated.\(^\text{16}\) The PES demonstrated the highest validity, since the index showed good correlation with six out of eight esthetic indices.\(^\text{17}\) This could be recommended for clinical research for evaluation of the esthetics of single-tooth implants and is currently the most reliable and validated index compared to all others.\(^\text{16}\) For evaluation of those indices, the use of clinical photographs has been recommended.\(^\text{18}\)

When interpreting the results of the present study, it has to be considered that different levels of buccal bone loss were included in the same experimental groups. Furthermore, the patient’s acceptance of their

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**Table 1** Mean ± SD PES Preoperatively and 1, 3, and 12 Months Postoperatively

<table>
<thead>
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<th>TGA</th>
<th>TNA</th>
<th>CG</th>
<th>P</th>
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<tr>
<td>12 mo</td>
<td>9.25 ± 3.01</td>
<td>8.6 ± 3.53</td>
<td>10.6 ± 2.22</td>
<td>.383</td>
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**Fig 1** Clinical courses of three patient cases followed by 1-year postoperative radiograph. (a) Maxillary right central incisor in the TGA. (b) Maxillary right central incisor in the TNA. (c) Maxillary right lateral incisor in the CG. From left to right: preoperative, postoperative, 1 year.

**Fig 2** Box plot showing mean ± SD PES over the complete follow-up.
esthetics before the surgical procedure was considered as a requirement for inclusion in the study, as, in the presence of an intact buccal lamellar bone, esthetics will not be changed by immediate implant placement and immediate restoration.10

This could also be shown and confirmed by the present study: Over an observation period of 12 months, only minimal changes of the PES for the three groups could be observed. However, upon separate assessment of the PES of the three groups, variable courses could be seen: While the PES of the CG remained practically constant and the postoperative PES of the TGA improved constantly by altogether more than 1 point, the PES values of the TNA temporarily even showed a deterioration by about 1 point before reaching baseline levels again only after 12 months. This change of the PES in the TNA group was due to changes that may be explained by a partly missing buccal lamellar bone; even after 12 months, the soft tissue contour and soft tissue texture could not reach their original baseline levels again. Soft tissue color only showed an improvement after 12 months, while the parameter of alveolar process deficiency was constantly rated better postoperatively.

For the TGA, these four parameters had been rated better than at baseline for each point in time and were consequently comparable with the CG. A striking feature was the significantly worse score in the preoperative assessment of the parameter of alveolar process deficiency for TNA and TGA vs CG, which was no longer detectable at the 1-month follow-up. After 12 months, this parameter was rated worse by only 0.1 (TGA) and 0.4 (TNA) vs that of the CG, for which it had been constantly rated high during the complete observation period.

With the TNA, an overall three of the seven parameters improved: the distal papilla, alveolar process deficiency, and soft tissue color. Similarly, three parameters also improved with the CG: alveolar process deficiency, soft tissue color, and soft tissue texture.
With the TGA, an improved rating could be achieved for five of seven parameters: distal papilla, soft tissue contour, alveolar process deficiency, soft tissue color, and soft tissue texture.

As a striking feature, the parameter mesial papilla deteriorated at the 12-month follow-up vs the preoperative baseline score in each of the three groups, while this was not the case for the parameter distal papilla, which even clearly improved in the TGA. As a presumptive reason for this, a trauma in the course of extraction, for which the tooth to be extracted is more frequently being worked on with levers from the mesial side, may be a potential explanation.

As a result of the missing buccal alveolar wall, the possibly largest impact had to be expected for the parameter tissue level. However, the present study was able to show that the worsening of the average rating of this parameter was only 0.1 (CG), 0.2 (TGA), and 0.3 (TNA), and no significant differences between the three groups were seen at any point in time. Thus, the results of this study are in obvious contrast to those of other studies reporting an increased risk of recession of the midfacial mucosa, especially in cases where the buccal lamella is not detectable in the preoperative radiograph, but they are also supported and confirmed by other studies.

Generally, it must be noted that, in contrast to other retrospective studies, no significant difference could be detected at any point in time between the three groups regarding the individual parameters and the different postoperative observation periods, with the exception of the parameter soft tissue color at the 3-month follow-up. It remains to be seen whether significant differences can be measured with a larger number of patients.

As a limitation of the present study, the relatively short observation period must be mentioned. In a recently published prospective randomized controlled clinical trial, the 5-year results comparing immediate implant placement in combination with alveolar augmentation and submerged healing to delayed implant placement after ridge augmentation in sites with a partially missing buccal plate showed that the main soft tissue changes occurred in the period up to the first months after implantation and was more or less stable thereafter. The esthetic score did not show any significant change over time.

In contrast to this finding, a retrospective study of 26 patients with facial recessions of 1 to 3 mm reported that a significant improvement in PES was seen after an average 45 months in patients with facial bone deficiencies having undergone immediate implant placement and buccal augmentation with autologous bone and connective tissue grafts. The improvement was more evident in cases with a greater recession and an additional connective tissue graft. In the present study, an improvement of the PES from 8.0 ± 3.09 to 9.25 ± 3.01 could also be seen in the TGA, while the other two groups showed no essential changes (TNA: 8.75 ± 2.75 vs 8.6 ± 3.53; CG: 10.6 ± 2.41 vs 10.6 ± 2.22). However, the change of the PES values from baseline to those after 12 months was not significant in any of the study groups. Thus, these results confirm those of an earlier study for TNA, but also indicate that an augmentation with bone substitute will not provide a significant improvement in the PES.

Conclusions

Within the limitations of this pilot study, it can be concluded that immediate implant placement with an immediate restoration in the esthetic zone of the maxilla might be a valuable alternative for restoring failing teeth even in cases where the buccal plate is missing, provided that the initial esthetic appearance is acceptable for the patient. Additional augmentation with bone substitute might improve the esthetic result, as even after 12 months, soft tissue contour and soft tissue...
texture could not reach their original baseline levels again in the TNA. A follow-up study with more patients will be needed to obtain final and conclusive results.

ACKNOWLEDGMENTS

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent had to be signed by the patients. The authors report no conflicts of interest.

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