Short Communication

The volume of proximal bone projection can determine the osseous contour after immediate implant placement and guided bone regeneration in severe labial bony deficiency

Monica Wang a, Kazuyo Kuribayashi Sato b,c, Lo-Lin Tsai d,e, Wei Jen Chang e,f, Yu-Chao Chang g,h**, Chih-Yuan Fang d,e*

a Department of Dentistry, Wanfang Hospital, Taipei Medical University, Taipei, Taiwan
b Department of Oral and Maxillofacial Surgery, Division of Oral Pathobiological Science, Faculty of Dental Medicine and Graduate School of Dental Medicine, Hokkaido University, Sapporo, Japan
c Department of Clinical Oral Oncology, National Hospital Organization, Hokkaido Cancer Center, Sapporo, Japan
d Department of Oral and Maxillofacial Surgery, Wanfang Hospital, Taipei Medical University, Taipei, Taiwan
e School of Dentistry, College of Oral Medicine, Taipei Medical University, Taipei, Taiwan
f Dental Department, Taipei Medical University Shuang-HO Hospital, New Taipei City, Taiwan
g School of Dentistry, Chung Shan Medical University, Taichung, Taiwan
h Department of Dentistry, Chung Shan Medical University Hospital, Taichung, Taiwan

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Anterior immediate implant placement (IIP) has many biological and esthetic challenges, including inevitable soft and hard tissue loss after extraction. Previous literatures have discussed the facial bone architecture and defective socket classification. However, none of them discussed the depression of the cervical root area which can be seen frequently after IIP in type IIB and U-shaped defective sockets. In our limited experiences, we found that the labial interproximal bone edges of type IIB and U-shaped defect dominated the esthetic result after IIP. With more labial projection of the interproximal bone present, better esthetic result could be expected in the facial aspect. With adequate evaluation of this osseous scalloping before
1. Introduction

Clinical demand for efficient, effective, and esthetic tooth replacement in the anterior teeth area has driven the development of immediate implant placement (IIP) and provisionalization.\(^1\)\(^-\)\(^2\) IIP success depends on several factors and residual socket morphology is one of the most important factors. Many classifications are proposed for different residual socket morphology.\(^3\)\(^-\)\(^8\) Facial bony defects widths are described as V-, U-, and Ultra-U (UU)-shape according to the mesial-distal extent of the defective area.\(^2\)\(^,\)\(^7\) Defect lengths can be categorized into the previous publications, we described labial defects using both Kan’s and Chu’s classification so that the defect can be evaluated simultaneously.\(^5\)\(^,\)\(^6\)\(^,\)\(^9\)\(^,\)\(^10\) However, we still lack adequate systems to describe the defect from the axial view. To evaluate the defective socket three dimensionally and improve implant positioning, an additional classification describing the socket from the axial section is necessary.

Based on the labial defect type, gingiva and papilla stability are widely discussed for aesthetic demands. Although facial gingival margin and papilla have been evaluated, few studies have discussed the sagittal loss of the cervical eminence due to facial osseous dehiscence after immediate implantation.\(^9\)\(^,\)\(^10\) In our experience, the labial osseous scalloping differs from that before tooth extraction. According to our follow-up cone beam computed tomography (CBCT), the degree of labial depression is easily identified in the axial section and represents the volume of newly formed labial bone. This article presented three cases with each exhibiting a failing single anterior tooth with type IIB and U-shaped labial defects. The root prominence was described in degrees of osseous scalloping. Low osseous scalloping meant no clinical identification root eminence or scalloping. In contrast, high scalloping presented the most clinically obvious root scalloping and reflected preexisting depressions in proximal bone. Due to limited case data, previous type IIB and U-shaped defect cases\(^9\)\(^,\)\(^10\) and the presented three cases were assessed for possible factors affecting the outcome of labial osseous scalloping in severe labial bone deficiency. Comparison of osseous scalloping, distance from proximal bone to implant surface, labial depression after IIP, tissue management methods, and follow-up periods are shown in Table 1. Taking our findings one step further, this paper also discussed a new axial classification based on the axial view of the socket and the projection of the proximal bone. The contributing factors in achieving functional and esthetic success were described as follows.

(1) The proximal bone heights determine the gingival level:

After atraumatic extraction and complete debridement of the socket, the residual mesial and distal proximal bone heights were needed to measure first, in concurrence with literatures. The distance between the projected connecting line of proximal bone peaks and the future crown margin should be no more than 3 mm.\(^2\) The residual mesial and distal proximal bone height should be no more than 3 mm.\(^2\) The residual mesial and distal proximal bone height should enough to support the papilla.\(^2\)

(2) The labial projections of residual proximal bones dominate the esthetic osseous scalloping:

The second step was to inspect proximal bone condition and evaluate space available for labial grafting. Minding minimal implant space required was very important at this stage. The labial-palatal bone width should be 1.5–2 mm from the implant surface to the projected connecting line of the labial defect after implant placement. These residual socket walls or proximal bone provided osteoblasts to proliferate and decided the flapless GBR results (Fig. 1 A1, and B1). At least 4 mm between the labial aspect of the proximal bone to the center of the projected implant position is needed, with extra spacing for mild labial drifting of the implant body during IIP. If appropriate, the implant site was prepared following standard drilling protocol. Extra-palatal osseous preparation might be done to keep the implant in the correct angulation, followed by implant placement. If this criterion could not be met, the labial implant surface might not be covered by regenerated bone. If the implant was placed too palatally, the labial offset of the crown might have hygienic issues. In such conditions, IIP should not be done and socket preservation or staging guided bone regeneration (GBR) protocols should be the next options.\(^9\)

(3) GBR procedures:

A collagen based resorbable membrane could be placed outside the labial plate to cover the most apical defect.
region without raising a flap. The particular bone graft materials were then gently packed to fill the gap (Fig. 1 A1, A2 and A3).9,10

(4) Immediate function or not:

If the primary stability was greater than 30NTcm and premature contact could be avoided, immediate function with a provisional crown or other super structure was a good option.10 When the primary stability was low, the GBR site had challenging conditions, or occlusion could not be avoided, primary closure of the wound with a rotative palatal flap was indicated. This step was dependent on the clinical conditions.2,6,9,10

Here we presented the case number two who cracked his right upper central incision with abscess formation as an example (Fig. 1D1). The horizontal root fracture was confirmed by the periapical radiography (Fig. 1D2). After discussion of all procedures and possible treatments with the patient, we performed IIP for him on 2013/1/28. After extraction of the fractured root and debridement of the socket with the additional vestibular incision subperiosteal tunnel access (VISTA) from the labial frenum, the IIP and GBR procedures were done (Fig. 1D3 to D6). The collagen base membrane and particular grafting materials were placed in the proper position through the VISTA easily (Fig. 1D5). The cervical eminence contour after surgical procedures is shown in Fig. 1D6 and the dimensional change after 5 month-follow-up is shown on Fig. 1D7 and D8. Because of the significant depression, the contouring connective tissue graft was done when performing stage II surgery by patient’s order. The patient felt satisfied about the esthetic result and stability after this combo treatment.

Table 1

| Tooth site | Osseous scalloping | Distance from proximal bone to implant surface | Labial depression after IIP | Soft tissue management | Hard tissue management | Follow up (years) |
|------------|--------------------|---------------------------------------------|----------------------------|------------------------|------------------------|-------------------|
| Case 1     | 22                 | >4 mm                                       | mild                        | CTG                    | FDBA + collagen membrane | 1.5               |
| Case 2     | 11                 | <2 mm                                       | severe                      | CTG                    | FDBA + collagen membrane | 7                 |
| Case 3     | 21                 | 2 mm–4 mm                                   | moderate                    | none                   | FDBA + collagen membrane | 1.5               |
| Wang et al.9 | 12                 | <2 mm                                       | severe                      | none                   | FDBA + collagen membrane | 8                 |
| Tseng et al.10 | 11                 | >4 mm                                       | mild                        | none                   | FDBA + collagen membrane | 5.5               |

Abbreviations: CTG, connective tissue graft; FDBA, mineralized freeze-dried bone allografts.

2. Discussion

Abscesses or fistulas are common root fracture signs and signify an osseous defect. Further discussion of the labial osseous defect morphology can aid clinicians in recognizing cases suitable for IIP and predicting the outcome. In our experience, patients with more protrusive root eminences had a more prominent subsequent depression of the cervical eminence (Fig. 1 A3, B3, and C3). This phenomenon reflected the U-shaped defect definition as bone destruction at the mesial and distal root surfaces. The remaining alveolar bone after tooth extraction appeared thin and disappared during healing. When the residual labial plate disappeared, the most labial proximal bone dominated the volume of labial bone regeneration (Fig. 1 A3, black arrows). High osseous scalloping signified the depression of proximal bone, which further indicated adjacent labial support limitations and the consequent lack of a source of osteoblasts. From this review, a gap of at least 1.5–2 mm from the labial interproximal bone and implant surface is necessary to generate enough labial bone and support the facial gingiva. Instead of the thin residual socket wall, the edge of the proximal bone is regarded as the GBR limitation. If the imaging connecting line between the proximal bone is too close to the implant, less than 1.5 mm, the clinician faces a higher failure risk. In contrast, a distance greater than 4 mm is ideal for IIP and GBR with the safest results (Fig. 1 A1, B1, and C1), though a 2–4 mm gap is also acceptable (Fig. 1 A2, B2, and C2). Within experimental limits, the cervical eminence does not protrude like the natural tooth root even with grafting to bolster bone volume.9 This may be affected by the resorption pattern of graft materials, mineralized freeze-dried bone allografts (FDBA), used in
Figure 1  Illustrations of the difference of regenerated labial bone after IIP and GBR according to the depressive contour of proximal bone. (A) The drawings show the IIP and GBR procedures in different osseous scalloping condition. The black arrows indicate the key locations determining the level of bone regeneration. (B) The results after GBR. (C) CBCT from the axial view, respectively representing the varying bone level depicted in row B. (D) Series clinical and radiographic photographs of case number two. The clinical procedures and the dimensional changes of the cervical eminence in different stages were shown.
our cases. To verifying the difference in using long-lasting grafting material, further research is needed.

To prevent further facial bone loss, Chu et al.6 covered the labial defect from inside the socket using ice-cream cone shaped membrane without detaching the labial periosteum. However, we found that the residual facial bone wall might become thin and resorb easily even without periosteum detachment. For better labial defect housing, minimal detachment of the periosteum along the bony edge of the labial defect can create space for membrane placement without a vertical releasing incision. A resorbable membrane can also be placed outside the labial bone so the defect can be fully grafted and avoid particular graft leakage. Labial dissection should be limited to avoid extra membrane movement. The labial gingiva is very vulnerable so the graft material must not be over-packed. If the particular grafting material is unstable or the insertion torque is not ideal for immediate function, a palatal rotative flap is highly recommended. Once immediate function is in consideration, the super structure can help in holding the graft and papilla.

Although valuable information can be gathered from this study, the limitations should also be acknowledged. This data collection involved a small number of patients and therefore the effects of more minor factors and their combinations could not be detected. A larger sample size and further studies would provide more distinguishing evidence on factors affecting cervical eminence esthetics of single maxillary anterior implants.

3. Conclusion

In addition to function, implants in the anterior region require greater attention to esthetic demands. Apart from the papilla and gingiva margin, patient concerns with the root eminence and gingival scalloping are esthetic factors to be considered when conducting IIP, especially in cases with type IIB and U-shaped defective sockets. In our limited experience, the proximal bone provides a good source of osteoblasts and the volume therefore determines the resulting bone growth. For better understanding of the outcome of GBR, the defect shape is better assessed from the view of the axial section. Particular bone grafting with a collagen based resorbable membrane can regenerate the labial osseous defect to an extent in cases with enough labial palatal depth and proximal bone. In our review of cases and literature, the hard and soft tissue scalloping and level of proximal bone is directly associated with the degree of labial cervical eminence depression.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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