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Original Article

Split-crest technique with inlay bone block grafts for narrow posterior mandibles: a retrospective clinical study with a 3-year follow-up

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Abstract: The use of the split-crest technique (SCT) and bone block grafts provides benefits to horizontal bone augmentation. However, no information is currently available to evaluate the clinical effects of SCT combined with inlay bone block grafts on soft and hard tissues of the narrow posterior mandibles. In this study, 56 healthy patients underwent SCT to augment the alveolar ridge width. Implant placement was performed 3 months after SCT, and the implants were restored 3 months after placement. A planned follow-up was performed to analyze various clinical features, including X-ray radiographs, alveolar ridge width, and keratinized mucosal width, after SCT to evaluate the success of the procedure. The incisions healed well in all patients. The average initial alveolar ridge width was 2.78 ± 0.56 mm, which increased to 6.67 ± 0.60 mm after SCT. Three months later, this width declined slightly to 6.19 ± 0.48 mm. The average initial keratinized mucosal width was 2.83 ± 0.66 mm, which increased to 6.00 ± 0.71 mm 3 months later. Both at 3 months and 1 year after the procedure, vertical bone loss at the buccal sites was 1.32 ± 0.56 mm and 1.94 ± 0.54 mm, respectively. Survival rates of the implants were 100% after 3 years. SCT with inlay bone block grafts was successfully applied to narrow posterior mandibles with efficient augmentation of soft and hard tissue widths. The findings of this study aim to identify future beneficial applications of SCT.

Keywords: Split-crest technique, posterior mandible, inlay bone block grafts, keratinized mucosa

Introduction

Survival rates for implants of the oral cavity are very high, typically above 90% after 10-15 years. As a result of the development of oral implant techniques and the advances in implant design and treatments, it has become easier to obtain better implant stability and osseointegration [1]. Moreover, adequate bone volume is a prerequisite for implantation and satisfactory aesthetic outcomes [2]. The most common cause of an alveolar bone defect is atrophy after a tooth extraction. Major changes to an extraction site can occur up to 1 year after a tooth extraction. For instance, bone resorption of approximately 3.8-6.1 mm may appear in the labial or lingual alveolar bone plate, although the likelihood of this loss is significantly lower at 3-12 months after tooth extraction [3]. Scipioni et al. [4] suggested that bone of at least 1-1.5-mm thick should remain on both the buccal and lingual/palatal aspects of the implant(s) to ensure a successful outcome. Moreover, the minimal buccolingual width required for implant placement is approximately 5.5 mm [5]. Therefore, protocols for successful implant placement frequently suggest that bone augmentation be performed prior to implantation.

Several methods can be performed for bone augmentation: the split-crest technique (SCT), bone block grafting, and guided bone regeneration (GBR) [6]. SCT was first described by Nentwig in 1986 [7]; it is a simple, rapid, and a reliable method used for the expansion of an atrophic alveolar crest [6]. This technique has positive, reliable clinical outcomes for horizontal bone augmentation in both the maxillary and mandibular regions [8-10]. Moreover, the recommended width needed to perform SCT for a narrow alveolar ridge is 3-4 mm [11]. Better results have been achieved in the maxillary region than in the mandibular region given that the latter is thicker, harder, and possesses more brittle cortical bone. Moreover, the risk of a bone fracture is significantly higher in the mandibular region than in the maxillary region during SCT, particularly when the surgical site must be expanded into the mandibular region [12, 13]. However, we have treated many mandibular cases with SCT and achieved satisfactory outcomes for the augmentation of soft and hard tissues. Furthermore, few studies have reported the use of SCT in the mandibular region. Therefore, the main purpose of this retrospective study was to present and evaluate the clinical effects of SCT use for narrow posterior mandibles.

Osborn reported a staged method for bone augmentation: splitting and extending the alveolar crest, filling the expanded space with autogenous bone or hydroxyapatite, and placing the implant after 8-12 weeks [14]. A staged approach for implant reconstruction with ridge splitting results in a higher implant success rate and better buccal cortical bone preservation [15]. The expanded space or gap can be filled with either a bone substitute or autologous bone. Interpositional autogenous bone grafts have been used to improve healing in the gap after SCT [16]. Based on our clinical experience, if this gap is filled with particulate grafts, the grafts are subjected to force by the surrounding tissue and are unable to resist the resilience of the bone plate, thus decreasing the success rate of the procedure. Additionally, particulate grafts may leak in cases of wound dehiscence. However, patients with implanted bone block grafts typically do not experience this complication. Based on this information, autogenous bone block grafts are recommended for filling the gap after SCT for narrow posterior mandibles.

Inlay grafts serve as a favorable environment for angiogenesis and osteogenic cell mobilization because they lie in direct contact with the native bone marrow of the recipient site [17]. Moreover, a high-quality blood clot can be generated in the gap if the vertex is well sealed and will eventually be replaced by bone. This immature osseous tissue develops into load-bearing lamellar bone at the implant interface [18]. Thus, inlay autologous bone block grafts are recommended for use after SCT.

According to our clinical practice and observations, the use of SCT with inlay autologous bone block grafts for narrow posterior mandibles has achieved promising outcomes in the augmentation of both soft and hard tissues. In particular, soft tissues often show evidence of keratinized mucosal widening. Therefore, we conducted this clinical study to verify the clinical effects of SCT with inlay bone block grafts on soft and hard tissues in patients with narrow posterior mandibles. We measured and analyzed the width changes in the alveolar ridge and keratinized mucosa (primary outcome parameters) as well as vertical bone loss at buccal sites (secondary outcome parameter) at different time points.

Materials and methods

Patients and materials

This retrospective study was approved by the Ethics Committee of Stomatological Hospital, Southern Medical University (201909). In this study we included a total of 56 patients who were treated with SCT between April 2015 and October 2015 and presented with partial edentulism in the posterior mandibular region. These patients included 34 females and 22 males (aged between 20-67 years). A piezosurgery device [Sofia (FC), Italy], extraction kit (SBP 0750; Silfradent), and osteotomy kit (SBP 0700) were used for the procedures. A bone substitute (deproteinized bovine bone material; Bio-Oss®, Geistlich Pharma AG, Switzerland) and collagen membrane (Bio-Gide®, Geistlich Pharma AG) were used as biomaterials.

Inclusion criteria

The patients included in the study had type IV bone quality (Cawood & Howell classification) [19], a narrow alveolar ridge width of less than 4 mm (1-4 mm), and a keratinized mucosal width of greater than 2 mm.

Exclusion criteria

Patients were excluded from the study if they had any of the following criteria: a history of smoking, systemic disease, or any related sur-

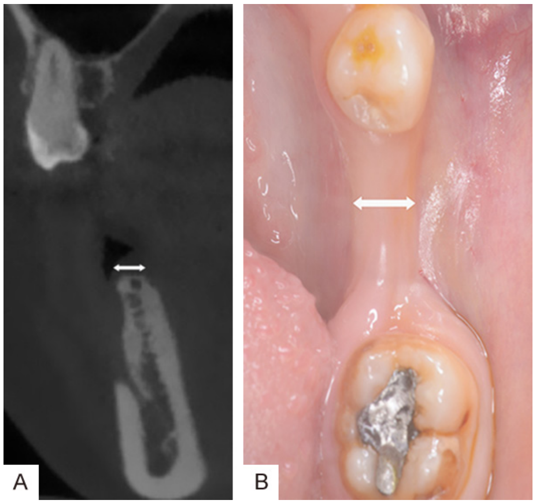

Figure 1. Preoperative CBCT and clinical examination were used for the measurement alveolar ridge width (A. White arrow) and keratinized mucosa width (B. White arrow).

gical contraindication, such as uncontrolled high blood pressure, acute myocardial infarction (within the past 6 months), or a psychological or psychiatric complication. The local exclusion criteria included any oral infection and uncontrolled periodontal disease.

Procedure and timeline of the entire treatment

All patients underwent preoperative cone beam computed tomography (CBCT, NewTom VGi; NNT software version 9.0, NewTom Inc., Verona, Italy) and a clinical examination acquire the measurements of the alveolar ridge width (**Figure 1A**, white arrow) and the keratinized mucosal width (**Figure 1B**, white arrow). SCT with an inlay bone block grafts was performed using piezosurgery for all cases. Three months after SCT, all patients underwent implant placement. Restoration was performed 3 months after implant placement. The survival rates of the implants were analyzed during the 3-year follow-up and included clinical oral examinations of the hard and soft tissues, and radiographic examinations (**Figure 2**). Data on the alveolar ridge width were collected preoperatively, postoperatively, and 3 months after the SCT procedure. The keratinized mucosal width was defined as the distance between the buccal and lingual mucogingival junction of the attached gingiva, and was recorded 3 months after the SCT procedure. Vertical bone loss at the buccal sites was recorded 3 months and 1 year after the SCT procedure.

SCT with inlay bone block grafts

All patients received oral antibiotics for 30 minutes preoperatively (0.375 g cefaclor sustained-release tablets and 1.2 g/L chlorhexidine mouth rinse). Local anesthesia was administered preoperatively, as well. This surgical procedure was divided into three steps: SCT, inlay bone block grafting, and buccal GBR.

For SCT, a linear incision was made along the midline of the keratinized mucosa. Then, full-thickness envelope flaps were lifted to expose the alveolar crest and buccal bone plate. After the flaps were lifted, the osteotomy line of the bone cortex was found along the middle of the crest and deep in the bone marrow (the osteotomy depth was approximately 10 mm, which should be adjusted according to the height of the alveolar ridge from the mandibular alveolar nerve; **Figure 3A**, white arrow). The osteotomy line of the buccal bone plate was laterally placed at a safe distance (at least 2 mm) from adjacent teeth and deep in the bone marrow along the root crown (**Figure 3A**, black arrow). When the basal bone cortex of the buccal plate was very thick (>2 mm), a longitudinal basal osteotomy (bone groove) was performed on the surface of the vestibular bone to increase bone elasticity and improve mobilization. A chisel was then used to separate the buccal bone plate to generate a greenstick fracture along the alveolar ridge. Next, using a "tapered bone expander" (Ankylos®, Germany), the alveolar fractured plate was gradually compressed until the gap width reached 3-5 mm.

For inlay bone block grafting, the cortical bone block (approximately 3.5 mm in diameter) was harvested from the ipsilateral external oblique line after SCT using a bone trephine (≥3.5 mm in diameter, adjusted according to the gap width and bone plate resilience). Then, multiple cortical bone blocks were inserted into the split gap (**Figure 3B** shows one bone block, white rectangular region) to resist the resilient force of the bone plate and seal the gap crest.

For the buccal GBR, pores were drilled with a round burr directly into the marrow cavity of the basal part of the bone to allow nutrients and osteoblasts to permeate the bone substitutes, which were then placed around the lateral area of the separated bone plate (**Figure 3C**, white rectangular region). Excess bone substitute was removed after this step. Then, a collagen

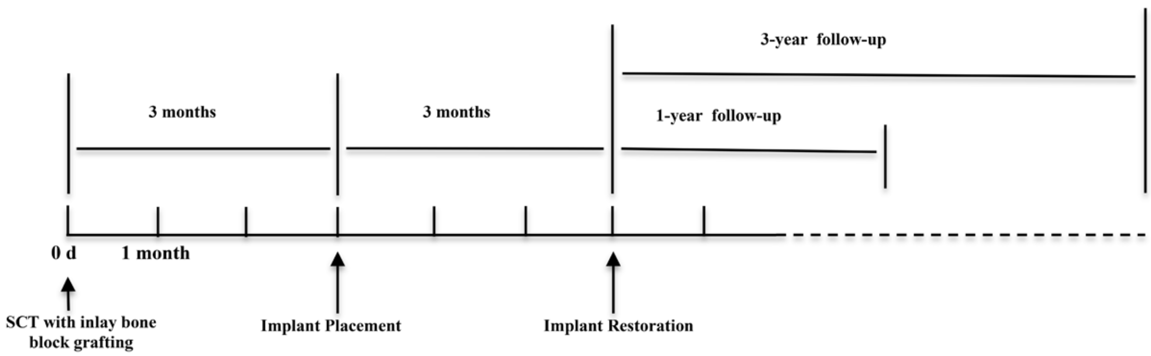

Figure 2. Procedure and timeline of the entire treatment.

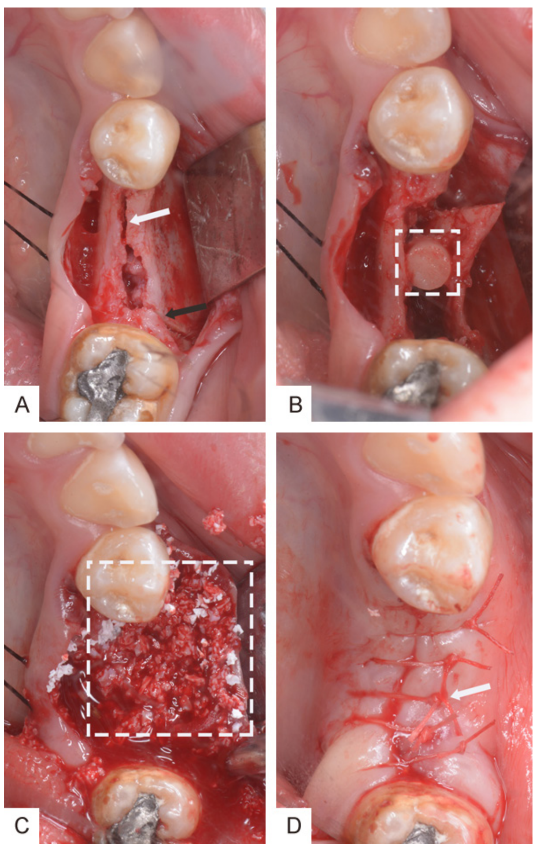

Figure 3. Surgical procedure of SCT with inlay bone block grafts. After the flaps were lifted, the osteotomy line of the bone cortex was found along the middle of the crest and deep in the bone marrow (A. White arrow). The osteotomy line of the buccal bone plate was laterally placed at a safe distance (at least 2 mm) from adjacent teeth and deep in the bone marrow along the root crown (A. Black arrow). Multiple cortical bone blocks were inserted into the split gap (B shows one bone block, white rectangular region). Bone substitutes were placed around the lateral area of the separated bone plate (C. White rectangular region). Finally, an absorbable suture was used to close the wound under microtension (D. White arrow).

membrane was applied to close the wound (the amount of bone substitute and the size of the membrane were selected according to the teeth range).

Slight loosening of the mucosal tissue was performed, and no bone substitutes were tamped into the gap. Finally, an absorbable suture was used to close the wound under microtension (**Figure 3D**, white arrow). Routine anti-inflammatory treatments (0.375 g cefaclor sustained-release tablets) were applied twice per day for 5 days postoperatively.

Implant placement

Clinical examinations of the keratinized mucosa were used to identify any increase at the alveolar crest 3 months after the SCT procedure (**Figure 4A**, white arrow). Envelope flaps were lifted to expose the alveolar crest (**Figure 4B**, white arrow) and the buccal bone plate. Next, placement of the implants (Zimmer; diameter: 3.7-4.1 mm, length: 8-11.5 mm) was performed (**Figure 4C**), and the healing caps were installed (**Figure 4D**). The size of the implant was based on the width of the alveolar crest. If the width was still insufficient, bone condensation, bone expansion, and GBR were performed prior to implant placement. Both a postoperative panoramic examination (**Figure 4E**) and CBCT (**Figure 4F**) were performed to evaluate the effects of the procedure.

Implant restoration

The healing status of the keratinized mucosa was examined 3 months after implants placement (**Figure 5A**). Implants with screw-retained restorations were routinely completed for each patient (**Figure 5B**, white rectangular region),

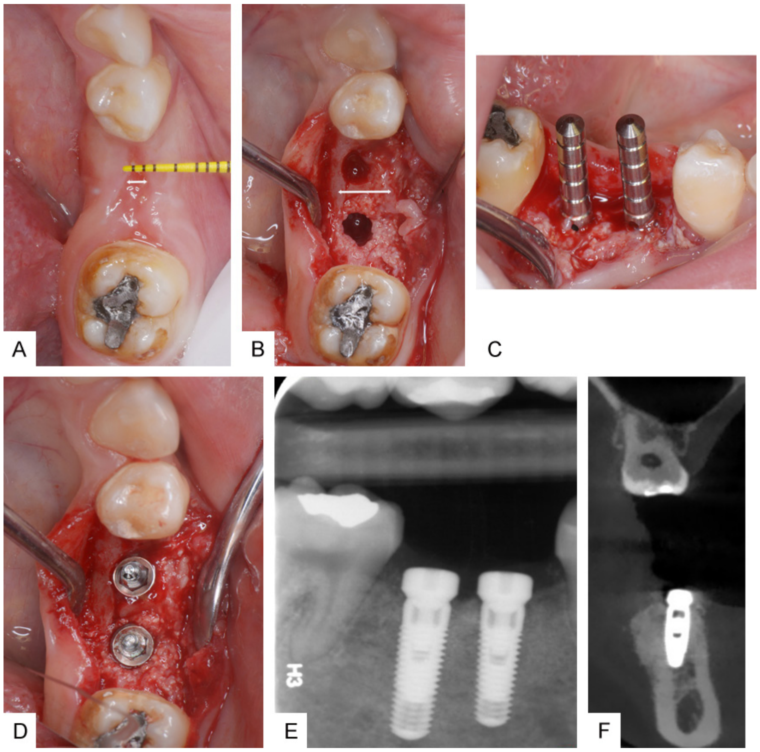

Figure 4. Surgical procedure of the implant placement. The increased keratinized mucosa was discovered at the alveolar crest 3 months after the SCT procedure (A. White arrow). Envelope flaps were lifted to expose the alveolar crest (B. White arrow) and the buccal bone plate. Next, placement of the implants was performed (C) and the healing caps were installed (D). Postoperative panoramic examination (E) and CBCT (F) were performed to evaluate the effects of the procedure.

and the occlusal relationship of the dentition was examined (**Figure 5C**, the black arrow indicates tooth 44 and the white arrow indicates tooth 45). In the case shown, splinted implant restorations provided implant stability and prevented food impaction. A postoperative panoramic examination (**Figure 5D**) was performed to evaluate the effects of the implant restoration.

Success and survival rates of implants

The criteria for implant success and survival used in for this study were selected according to the study by Misch et al. [20].

Statistical analysis

Shapiro-Wilk test was used to evaluate the normality of the data. Statistical analyses of the alveolar ridge width were performed using Friedman's test (nonparametric test) at different time points. The paired-sample *t* test was used for comparisons of keratinized mucosal width and vertical bone loss at different time points (SPSS software, version 13.0, IBM Corporation, Armonk, NY, USA), with an α level of 0.05. Data are presented as the mean ± standard deviation ($\bar{x} \pm S$). *P* values less than 0.05 were considered statistically significant.

Results

Study data

Among the 56 patients, 52 were consecutively treated and 4 dropped out (the dropout rate was 7.14%) during the defined study period. Two cases dropped out because of intraoperative complications (fractures of the buccal bone plate), and two cases were lost to follow-up. Regarding the remaining patients, 72 delayed implants were performed. Most patients did not experience any obvious discomfort during follow-up. Ten patients had an insufficient alveolar ridge width, thus requiring the need for additional bone augmentation (GBR) for implant placement. Four patients presented with mild pain and mild local swelling within the first 3 days after SCT, which gradually receded within a 5-day period postoperatively. Exposed edges of separated bone plates were detected 1 week after SCT in four patients with a thin gingival biotype, and all wounds healed within 1 week after the edges were polished with a high-speed turbine handpiece. One patient experienced an exposed buccal bone plate 1 month after SCT. In this case, the exposed bone was removed, and GBR and implant placement was performed after 2 months.

Changes in alveolar ridge width at different time points

Changes in the alveolar ridge width at different time points are shown in **Figures 6** and **9A**. Postoperative CBCT revealed a substantial in-

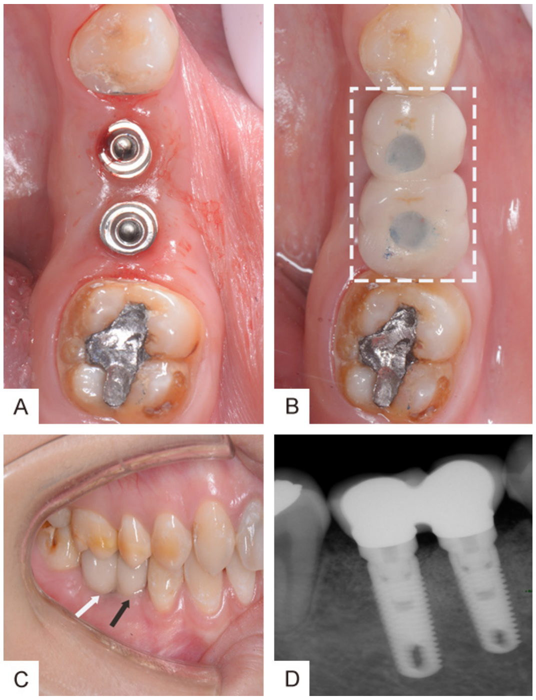

Figure 5. Implant restoration. The healing status of the keratinized mucosa was examined 3 months after implants placement (A). Implants with screw-retained restorations were routinely completed for each patient (B. White rectangular region), and the occlusal relationship of the dentition was examined (C. The black arrow indicates tooth 44 and the white arrow indicates tooth 45). Postoperative panoramic examination (D) was performed to evaluate the effects of the implant restoration.

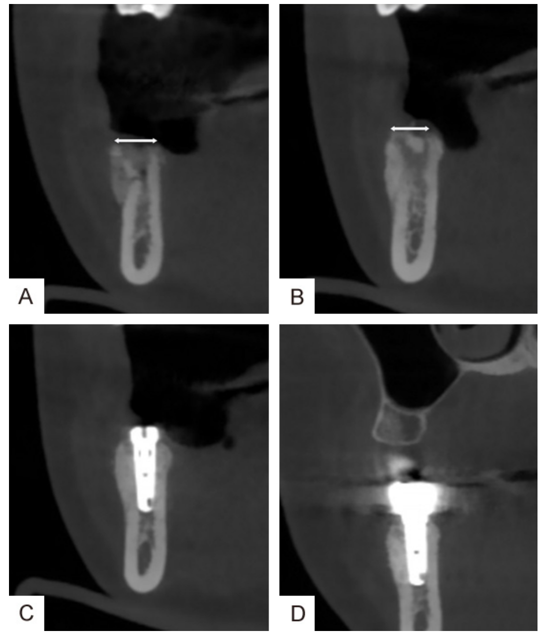

Figure 6. Changes in alveolar ridge width at different time points. Postoperative CBCT revealed a substantial increase in the alveolar ridge width after splitting (A. White arrow), and few particles of the bone substitutes were found in the bone marrow cavity. A displacement of 3-5 mm was detected between the separated buccal and lingual bone plates 3 months after SCT (B. White arrow). Overall, implant placement was stable and in the appropriate 3D position (C). Moreover, (D) shows the stability of the alveolar ridge bone after prosthetic restoration.

crease in the alveolar ridge width after splitting (**Figure 6A**, white arrow), and few particles of the bone substitutes were found in the bone marrow cavity. A displacement of 3-5 mm was detected between the separated buccal and lingual bone plates (**Figure 6B**, white arrow), and bone substitutes were deposited with uniform density outside the buccal bone plate 3 months after SCT. Overall, implant placement was stable and in the appropriate 3D position (**Figure 6C**). Moreover, **Figure 6D** shows the stability of the alveolar ridge bone after prosthetic restoration.

After the SCT procedure, the morphology of the vestibular sulcus was restored, the buccal bone plate became steeper, and the average initial alveolar ridge width (2.78 ± 0.56 mm) significantly increased to 6.67 ± 0.60 mm. After 3 months, the alveolar ridge width significantly decreased to 6.19 ± 0.48 mm (**Table 1** and **Figure 9A**, $*P = 0.00 < 0.05$).

Changes in the keratinized mucosal width at different time points

Figure 7A (white arrow) shows the preoperative keratinized mucosal width, which expanded along the incision on the alveolar ridge crest, as determined during clinical examinations at 2 weeks (**Figure 7B**, white arrow indicates keratinized mucosal width and black arrow indicates increased keratinized mucosal width) and 3 months (**Figure 7C**, white arrow indicates keratinized mucosal width and black arrow indicates increased keratinized mucosal width) after SCT. The average initial keratinized mucosal width (2.83 ± 0.66 mm) significantly increased to 6.00 ± 0.71 mm 3 months after the SCT procedure (**Table 1** and **Figure 9B**, $*P = 0.00 < 0.05$).

Vertical bone loss at buccal sites at different time points

Vertical bone loss was 1.32 ± 0.56 mm at buccal sites 3 months after SCT and significantly

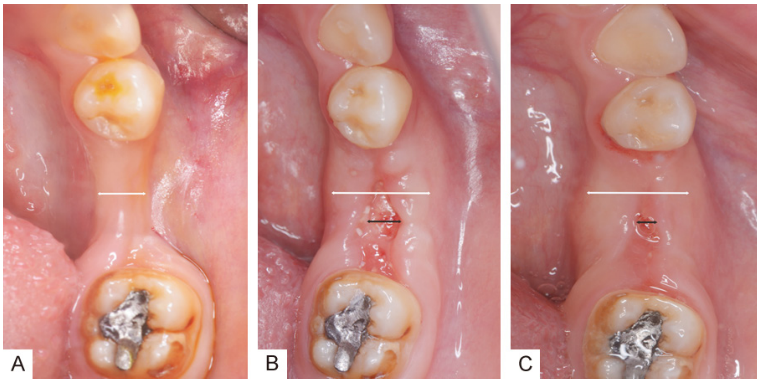

Figure 7. Changes in the keratinized mucosal width at different time points. (A) (white arrow) shows the preoperative keratinized mucosal width, which expanded along the incision on the alveolar ridge crest, as determined during clinical examinations at 2 weeks (B). White arrow indicates keratinized mucosal width and black arrow indicates increased keratinized mucosal width and 3 months (C). White arrow indicates keratinized mucosal width and black arrow indicates increased keratinized mucosal width after SCT.

decreased to 1.94 ± 0.54 mm 1 year after SCT (**Table 1** and **Figure 9C**, $^{*}P = 0.00 < 0.05$).

Follow-up

Clinical examinations revealed the ideal occlusal relationship of the dentition (**Figure 8A** and **8F**), as well as the stability of the implants and soft tissues (**Figure 8B** and **8G**, white rectangular region). Postoperative panoramic (**Figure 8C** and **8H**) and CBCT examinations (**Figure 8D**, **8E**, **8I** and **8J**) revealed that implant placement and restoration were stable and in the appropriate 3D position. **Figure 8** shows the stability of the soft and hard tissues. The survival rates of all 72 delayed implants were 100% at the 3-year follow-up.

Discussion

In previous studies, the average augmentation of the alveolar ridge width, after ridge splitting, was 2-3.5 mm when implants were inserted simultaneously at the appropriate timeframes [21, 22]. However, not all patients are eligible for simultaneous implant placement. In these cases, severe resorption of the buccal bone plate can result in an implant axis deviation on the lingual side. Therefore, we performed SCT with inlay bone block grafts for narrow posterior mandibles with delayed implants to increase the success rate of implantation. This method showed positive and promising curative effects: The alveolar ridge width increased to 6.67 ± 0.60 mm after the SCT procedure and decreased slightly to 6.19 ± 0.48 mm 3 months postoperatively. Remarkably, not only did the alveolar ridge become thicker, but the keratinized mucosa also became wider 3 months after the SCT procedure, increasing to 6.00 ± 0.71 mm. Although several methods are used for gingival augmentation, including a free gingival graft, connective tissue graft, cellular dermal matrix, collagen matrix, and apically repositioned flap [23-25], no previous study has reported SCT for keratinized mucosal augmentation. Therefore, this is the first study to report that SCT with inlay bone block grafts promotes the augmentation of both soft and hard tissues. The clinical effectiveness of this technique was positive, as summarized below.

With insufficient gingiva in the vicinity of an implant, there is a risk of gingival recession and crestal bone loss. Therefore, for long-term maintenance and management, as well as for aesthetics, the presence of an appropriate amount of gingiva is required [26]. Therefore, the benefits of widening the keratinized mucosa by SCT with inlay bone block grafts include the maintenance of long-term stability and the aesthetic results of the implant. An absorbable suture was used to close (or narrow) the wound under microtension after the SCT procedure. Thus, it is not necessary to suture the flaps completely together under a fully tensionless status in such cases. Hence, the wound does not usually achieve primary healing and wound dehiscence can be observed. Next, achieving an optimal blood supply promotes secondary wound healing without risk of infection. Therefore, wound dehiscence can achieve secondary healing and increase the keratinized mucosal width. In other words, the increase in keratinized mucosa could be the result of the secondary healing.

The risk of bone fracture is higher in the mandibular region than in the maxillary region because the mandible is harder and more brittle [27, 28]. To increase bone elasticity and

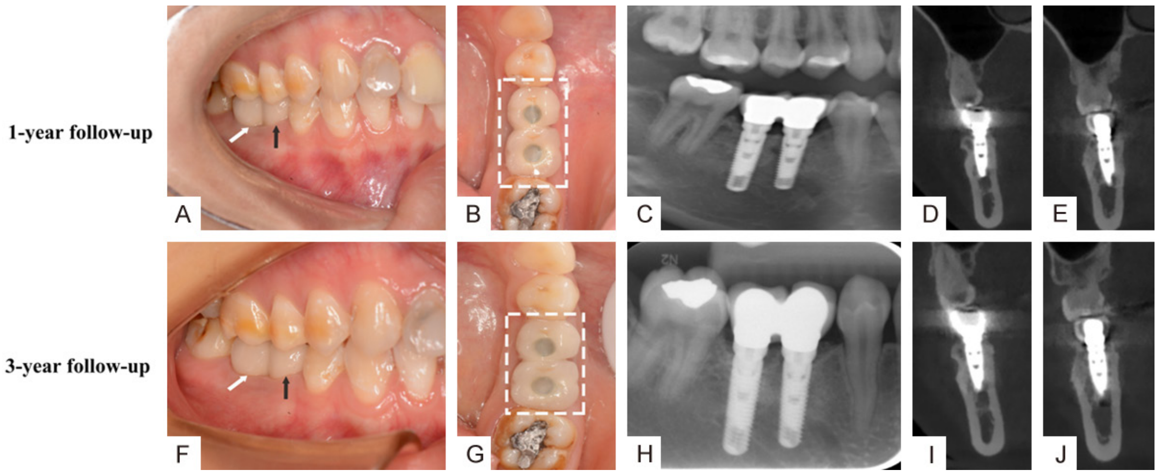

Figure 8. Follow-up. Clinical examinations revealed the ideal occlusal relationship of the dentition (A and F), as well as the stability of the implants and soft tissues (B and G) white rectangular region. Postoperative panoramic (C and H) and CBCT examinations (D, E, I, and J) revealed that implant placement and restoration were stable and in the appropriate 3D position.

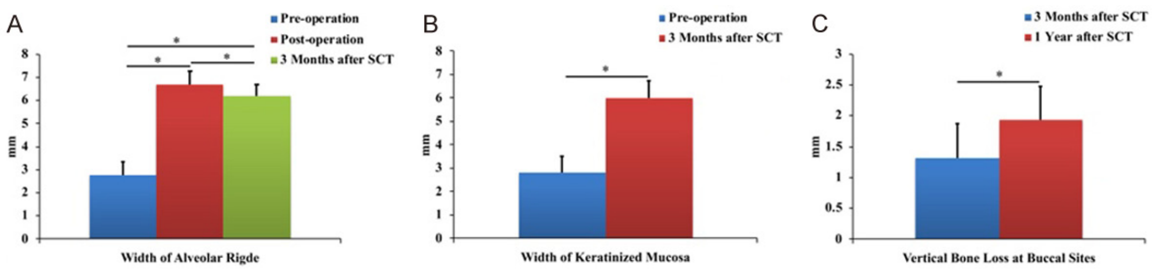

Figure 9. Changes in the alveolar ridge (A. *P = 0.00 < 0.05) and keratinized mucosa width (B. *P = 0.00 < 0.05), vertical bone loss at buccal sites at different time points (C. *P = 0.00 < 0.05).

Table 1. Changes in the alveolar ridge and keratinized mucosa width, vertical bone loss at buccal sites at different time points

Timepoint	Alveolar ridge width (mm)	Keratinized mucosa width (mm)	Vertical bone loss at buccal sites (mm)
Pre-operation	2.78 ± 0.56	2.83 ± 0.66	
Post-operation	6.67 ± 0.60		
3 Months after SCT	6.19 ± 0.48	6.00 ± 0.71	1.32 ± 0.56
1 Year after SCT			1.94 ± 0.54

improve mobilization, a longitudinal basal notch is sometimes made on the surface of the vestibular bone [29, 30]. To make the bone notch at the basal part of the mandible, at a distance far away from the ridge, full-thickness flaps should be raised to expose the basal part of the mandible. A negative aspect of this technique is that complete stripping could affect the microvascular perfusion of both the mucoperiosteal flap and the vestibular bone segment. The viability of the separated bone plate could thus undergo osteonecrosis. To provide a better blood supply for the vestibular bone segment, bone blocks were gently hammered into the split gap to seal the gap crest after SCT. Additionally, postoperative CBCT showed few particles of bone substitutes in the bone marrow cavity. This inlay method has several advantages. First, inlay bone block grafts serve as a favorable environment for angiogenesis [17]. However, if a sufficient amount of bone substitute is inserted into the bone marrow cavity, the prime nutrient supply to the separated bone plate would be disrupted. In contrast, when no bone substitute is inserted into the bone marrow cavity, a good blood supply ensures an adequate supply of nutrients to the surrounding tissues, particularly with respect to the separated bone plate. Finally, when the gap subsequently fills with a blood clot, the clot can be replaced with woven bone that develops into load-bearing lamellar bone at the implant interface [18]. Bone substitutes have been reported to decrease bone regeneration during early healing compared with autografts [31]. Moreover, human biopsy results after sinus augmentation with inorganic bovine bone confirmed that particles from bone substitutes can still be found approximately 4-10 years postoperatively [32, 33]. Therefore, bone substitutes likely affect the osseointegration of implants during early healing. Our recommendation to use little bone substitute in the bone marrow cavity may avoid this influence on the osseointegration of implants.

The key goal for the use of SCT with inlay bone block grafts is to promote the augmentation of soft and hard tissues and to maintain an optimal blood supply. To obtain an optimal blood supply for tissue healing after SCT, we designed a linear incision, without any releasing incision. Moreover, inlay grafts serve as a favorable environment for angiogenesis [17]. Finally, bone blocks were gently hammered into the split gap to seal the gap crest after SCT, and postoperative CBCT showed few particles of bone substitutes in the bone marrow cavity. In contrast, if a large amount of bone substitute is inserted into the bone marrow cavity, the prime nutrient supply to the separated bone plate could be disrupted.

The edges of the separated buccal bone plate should be covered with biomaterials that can act as a buffer to prevent the perforation of the soft tissue. Additionally, a large amount of bone substitute can be used to thicken the lateral part of the buccal bone plate. If the width gained after the SCT procedure is inadequate, or if the buccal bone plate is resorptive or becomes necrotic, buccal GBR should always be performed as a remedial measure.

As much as 1 mm of bone can be consumed when an osteotomy is performed using a microsaw. Therefore, to reduce bone consumption during the osteotomy procedure, we used a piezosurgery device was used (bone consumption: ≤ 0.5 mm) in this study. Compared with conventional burs and saws, the most significant advantage of piezosurgery is its selective cut. Hence, bone can be cut with relative ease, whereas soft tissues, including blood vessels, nerves, and mucosal tissues, remain unharmed [34]. Thus, this surgical technique is safe and can be used without the risk of soft tissue encroachment, particularly when applied to very narrow alveolar ridges. Because the mandibular cortex is thicker and more brittle than the maxilla, it is more difficult to split and involves the risk of fracture, which is an important intraoperative complication. When the separated bone plate on the vestibular side is completely fractured, rigid stabilization with a titanium plate or screw should be used for bone plate retention [35], and the treatment plan should be modified. If the decision is made to continue with SCT, it is necessary to wait 3 months to allow the bone to heal after implantation and wound closure before continuing with the original treatment plan. Another postoperative complication is exposure of bone. This can result from the lost resilience of the buccal bone plate when it is excessively split, resulting in a dissociative fracture that can cause osteonecrosis and affect bone healing. An exposed sharp edge of the separated bone plates indicates that a thin gingival biotype is present; the biotype should thus be determined before this technique is used. A suture applied under microtension should not be used in cases wherein the buccal bone plate has lost its resilience and a thin gingival biotype exists.

In conclusion, based on the primary and secondary outcome parameters, SCT with inlay bone block grafts was successfully applied to narrow posterior mandibles. The findings of this study may help to elucidate future beneficial applications of SCT. However, more clinical trials and further observations are needed.

Acknowledgements

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Disclosure of conflict of interest

None.

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