A new technique of two iliac cortical bone blocks sandwich technique for secondary alveolar bone grafting in cleft lip and palate patients

Vo Van Nhan* and Pham Nguyen Quan
Hong Bang International University, Vietnam

ABSTRACT

Objectives: To describe in detail treatment procedure and outcomes of a new technique of two iliac cortical bone blocks sandwich for alveolar cleft in patients with unilateral cleft palate. Materials and methods: Based on previous techniques, our clinical experience with 32 cleft sites had confirmed the alveolar cleft bone graft outcomes and implant success with new technique of two iliac cortical bone blocks sandwich. Patient selection criteria was patients over 15 years old, patients in good health for endotracheal anesthesia, patients already had palatoplasty, patients with complete unilateral alveolar cleft, lack of permanent tooth germ in the cleft and did not receive any alveolar cleft bone graft. The patients underwent general dental treatment and pre-surgical orthodontic treatment. Any tooth extraction was performed 2 months before bone graft if necessary. All patients underwent late secondary bone grafting for alveolar cleft. This paragraph focused on introducing new technique and clinical results with follow-up time of 96 months after alveolar bone grafting. Results: After 4 to 6 months, 100% of cases showed good mucosal healing. After 4 to 6 months' follow-up, the bone formation score I was 90.6% in 29 patients and score III was 9.4% in 3 patients. After 90 months, all 18 implants were recorded success in 15 patients remained follow-up. Conclusion: A new treatment method was suggested for patients with cleft lip and palate defect, not only to recover the function but also to meet the esthetic demand helping patients communicate confidently for community integration.

Keywords: *secondary alveolar bone graft, cleft lip and palate, unilateral alveolar cleft, dental implant*

1. INTRODUCTION

Anatomical deformity in patients with cleft lip and palate was a complex abnormality including both soft tissues (nose, lips, soft palate) and hard tissues (teeth, alveolar bone and hard palate). This defect affected the formation of tooth development, tooth eruption, malocclusion, masticatory function, deformities of the facial middle and lower third, pronunciation, esthetic and psychological problems [1]. Seventy-five percent of patients with cleft lip or cleft lip and palate was recognized with an anterior alveolar bone defect that can affect tooth development and contribute to the collapse of alveolar segments. Therefore, it is necessary to reconstruct the cleft, which facilitates the eruption of adjacent teeth, orthodontic or prosthodontic treatments of the edentulous area, and closure of symptomatic oronasal fistulas [2]. Two main obstacles for rehabilitation of alveolar cleft were the bone grafting and orthodontic treatment, because arch-width deficiency and dental crossbite was usually present due to maxillary hypoplasia. This paper presented the new treatment technique for alveolar cleft in patients with

Corresponding author: Dr. Vo Van Nhan
Email: nhanvv@hiu.vn

unilateral cleft palate based on previous clinical researches [3]. The objective was to describe in detail treatment procedure and outcomes of a new technique of two iliac cortical bone blocks sandwich for alveolar cleft in patients with unilateral cleft palate.

2. MATERIALS AND METHODS

Based on previous techniques, our clinical experience with 32 cleft sites had confirmed the alveolar cleft bone graft outcomes and implant success with new technique of two iliac cortical bone blocks sandwich. Patient selection criteria was patients over 15 years old, patients in good health for endotracheal anesthesia, patients already had palatoplasty, patients with complete unilateral alveolar cleft, lack of permanent tooth germ in the cleft and did not receive any alveolar cleft bone graft. The patients underwent general dental treatment and pre-surgical orthodontic treatment. Any tooth extraction was performed 2 months before bone graft if necessary. All patients underwent late secondary bone grafting for alveolar cleft. The treatment protocol was suggested in Figure 1. This paragraph focused on introducing new technique and clinical results with follow-up time of 96 months after alveolar bone grafting.

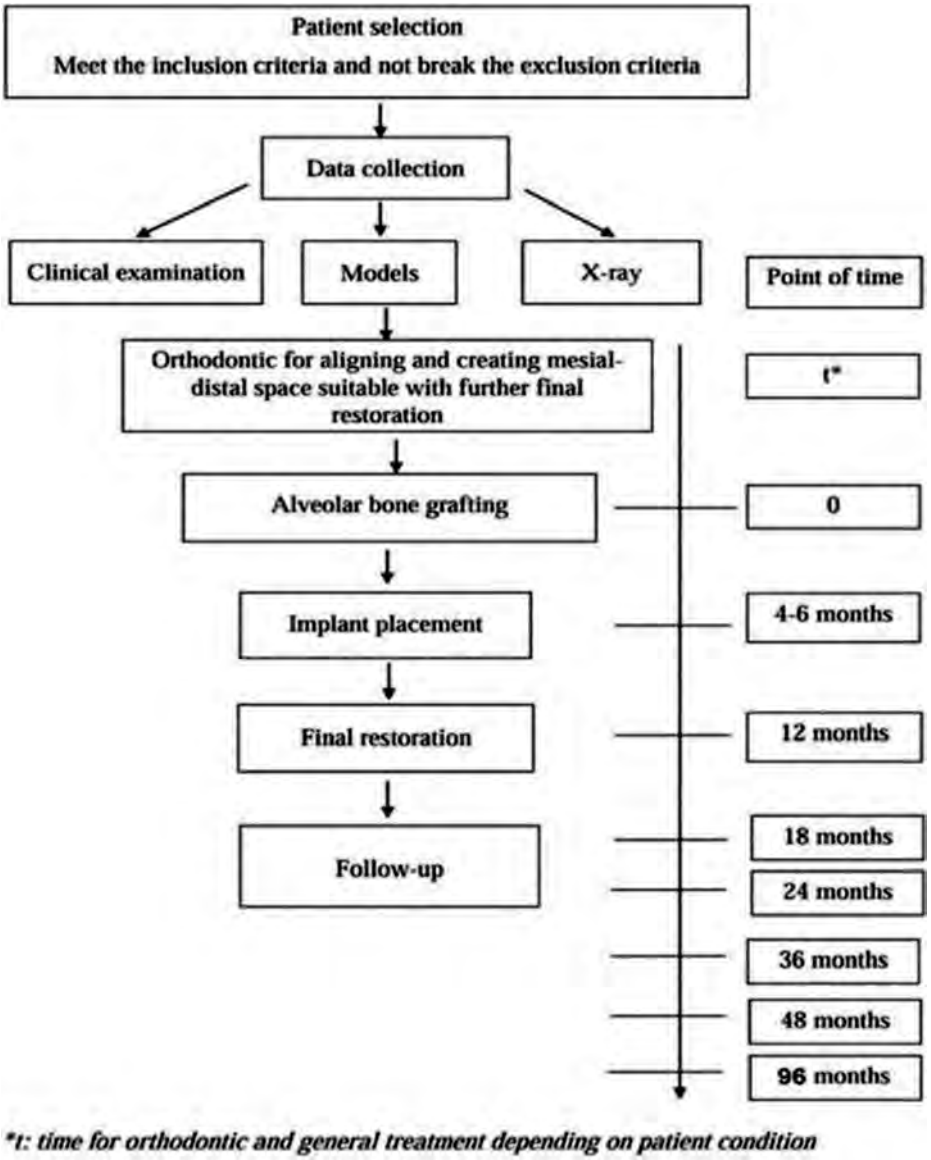

Figure 1. Treatment protocol for alveolar cleft bone graft

2.1. Iliac bone block harvesting surgery

The main objective of first incision was to avoid damaging the lateral femoral cutaneous nerve. Under general anesthesia, the location of the anterosuperior iliac spine was marked. The incision was performed beginning 1 cm posterior to this marked point, with approximately 5 cm parallel to the iliac crest. The margin of the iliac crest was exposed by cutting the fascia and periosteum. Then, the monocortical bone was cut with a piezotome ultrasonic device and removed with a chisel by applying a medial approach. The cancellous bone was harvested with curettes. A hemostatic sponge was placed, and periosteal and intradermal sutures of coated Vicryl 4.0 (Polyglactin 910; Ethicon, Somerville, NJ) were performed to close the wound. By combining the mean widths of the central incisor (about 8.5 mm), lateral incisor (about 8 mm), and canine (about 8.5 mm), the labial block size was required as 25 mm x 20 mm 5 mm (Figure 2A). The palatal bone block size was 15 mm x 20 mm x 5 mm due to wider alveolar cleft at the nasal floor. Thus, the harvested iliac bone was required the total size of 40 mm x 20 mm x 5 mm (Figure 2B).

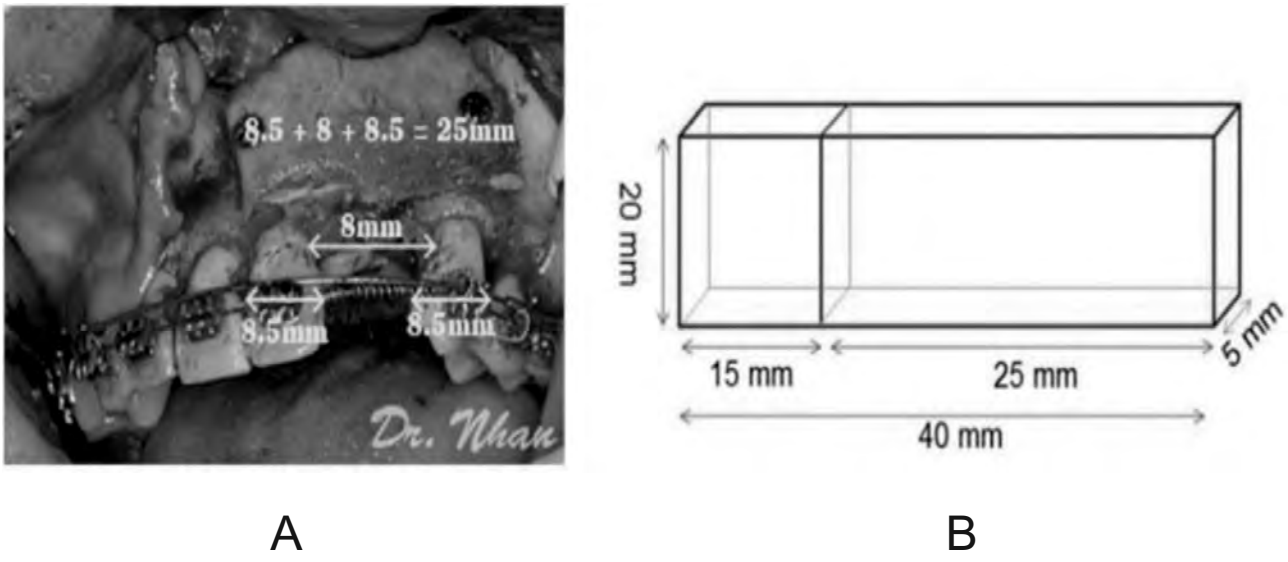

Figure 2. Bone harvesting technique at the iliac crest. (A) the size of the labial bone block. (B) the total size of the bone block harvested from the iliac crest.

2.2. Alveolar cleft bone graft surgery

Alveolar cleft bone grafting was performed using the two iliac cortical bone blocks sandwich technique (Figure 3). The incision was performed along the cleft margin under local anesthesia. In the labial, the incision was extended to about 2 - 3 adjacent teeth. Two vertical relieving incisions were made with 120° curved incisions at the ends. In the palate, the incision was continued from the cleft to the second premolar at each side, and a vertical relieving incision was applied from this area to 2/3 the distance from the gingiva margin toward the palatal midline, allowing anterior advancement of the palatal attached mucosa [4]. Full-thickness flaps were reflected labially and palatally. The labial flaps had periosteal relieving incisions, which ensured sufficient sliding of the flaps (Figure 5). After harvesting, the bone was divided into 2 corticocancellous blocks to fit to the cleft (Figure 6). All patients were indicated a preoperative antibiotic and oral antibiotics for 10 days postoperatively. The patients were hospitalized for 1 day for easy observation.

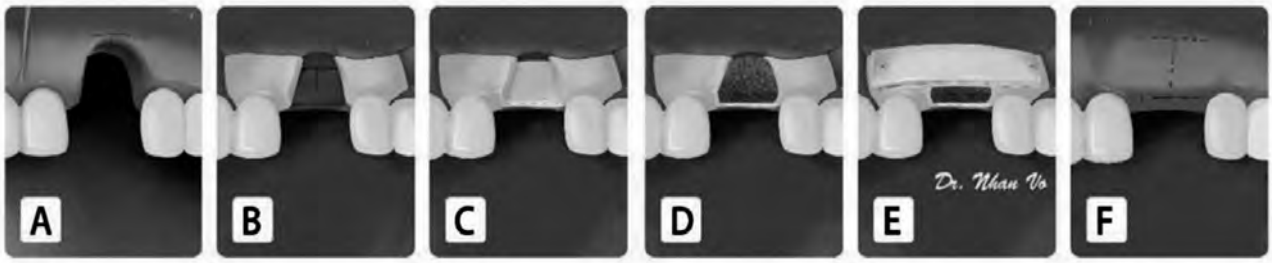

Figure 3. Illustration of the two iliac cortical bone blocks sandwich technique: (A) a flap design for alveolar cleft bone grafting. (B) the nasal flap closure. (C) the first bone block on the nasal lining. (D) Cancellous bone was packed on the first block. (E) the second bone block on the vestibular was secured by screws. (F) Wound closure.

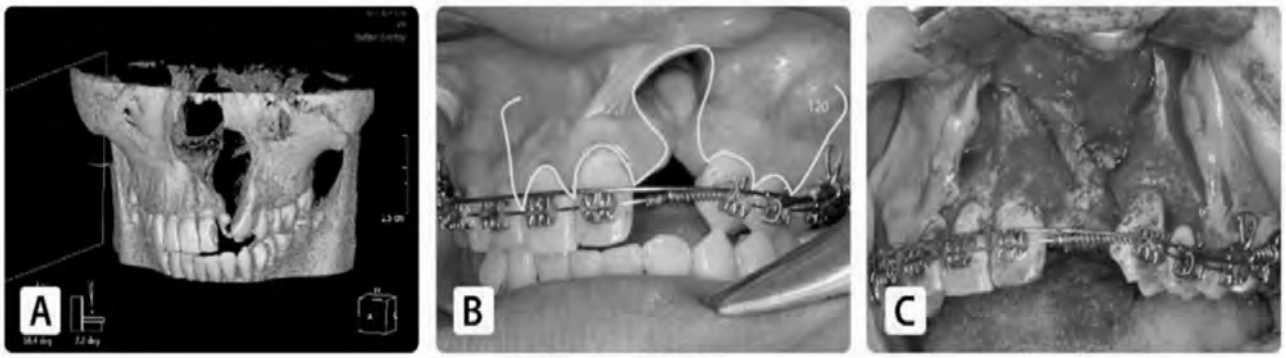

Figure 4. Bone grafting preparation. (A) the alveolar cleft on CT cone beam. (B) Pre-orthodontic and flap design for alveolar cleft bone graft surgery. (C) Nasal flap closure.

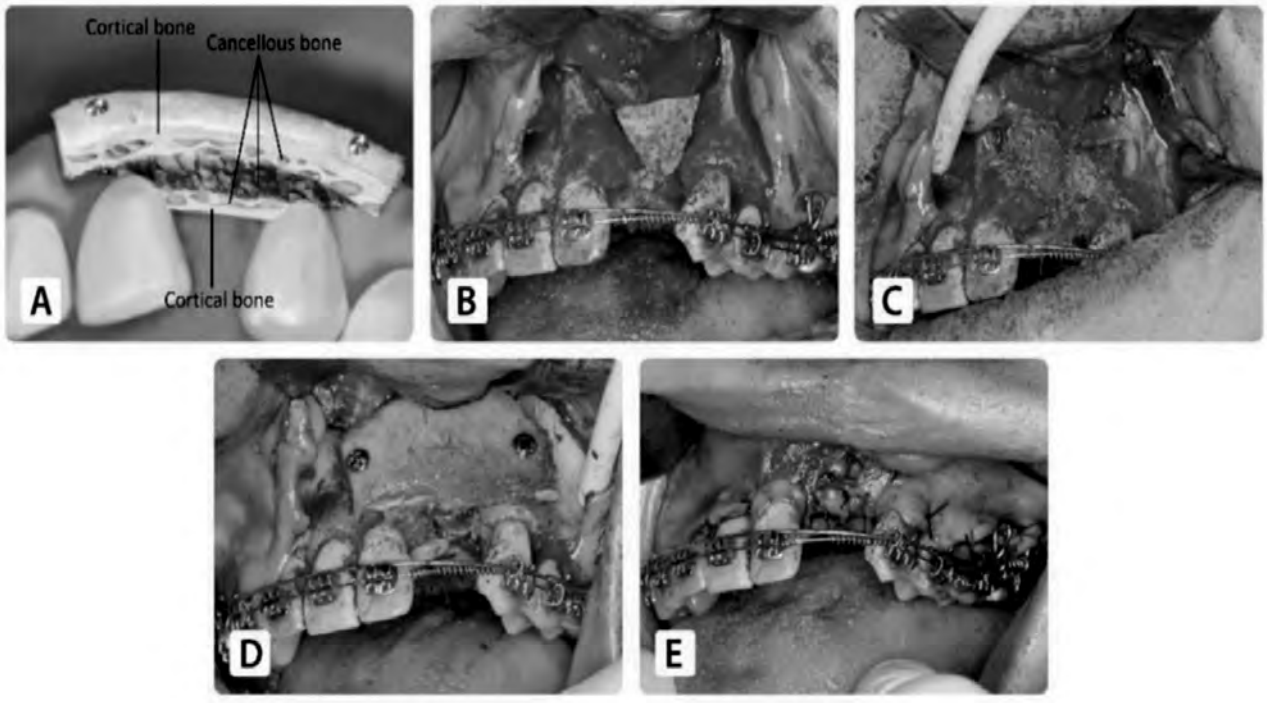

Figure 5. Alveolar bone grafting. (A) the technique of two iliac cortical bone blocks sandwich (B) the bone block on the nasal lining. (C) the cleft was nearly filled by cancellous bone. (D) the bone block on the vestibular was secured by screws. (E) Wound closure.

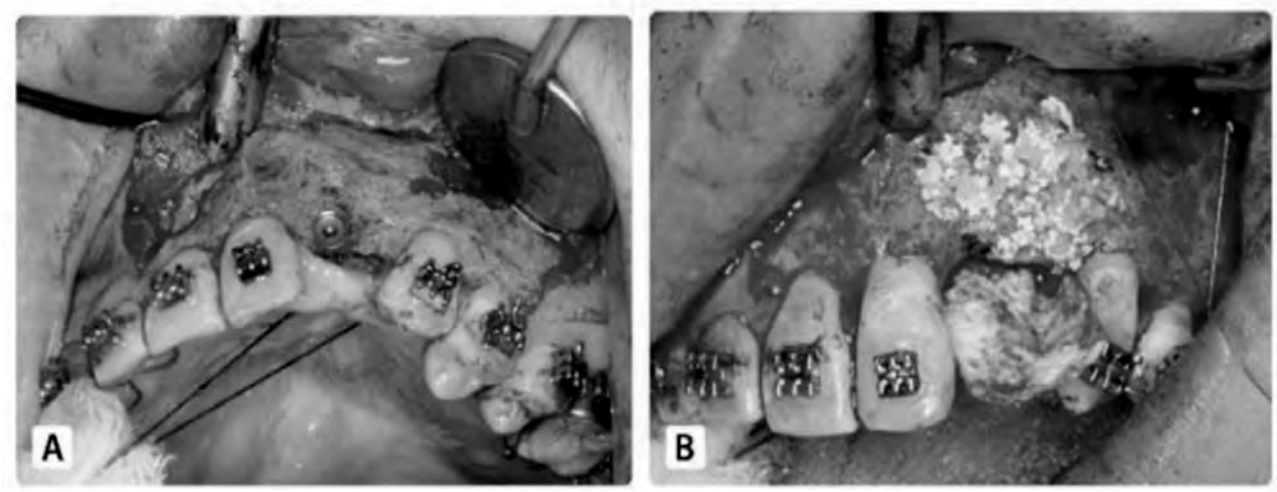

Figure 6. Dental implant placement after 4–6 months' bone grafting. (A) Dental implant placement. (B) Particulate additional bone grafting.

2.3. Implant placement and implant prosthodontics

After 4 to 6 months alveolar cleft bone grafting, an endosteal dental implant was placed in the grafted site with static guidance of an acrylic surgical stent (Figure 7A) [5]. The surgical procedure was performed under local anesthesia with undersized site preparation to achieve primary implant stability. Additional bone was placed simultaneously with implant insertion by the guided bone regeneration (GBR) or bone ring technique (large defects) and Osteon (30% hydroxyapatite and 70% β-tricalcium phosphate) was used with resorbable membrane (Genoss, Suwon, Korea) for GBR. A mixture of autogenous particulate grafting technique was used (Figure 7B). Autogenous bone harvested at the position of the implant bed by a 3-mm-diameter trephine bur was used as particulate bone graft. Bone ring grafting is a technique of 3-dimensional crestal bone augmentation for vertical bone loss. The bone ring was harvested from symphysis or retromolar in a manner similar to that of Stevens et al. [6]. After 6-month follow-up, a healing screw was placed. Impressions were made for the final restoration after three weeks (Figure 1).

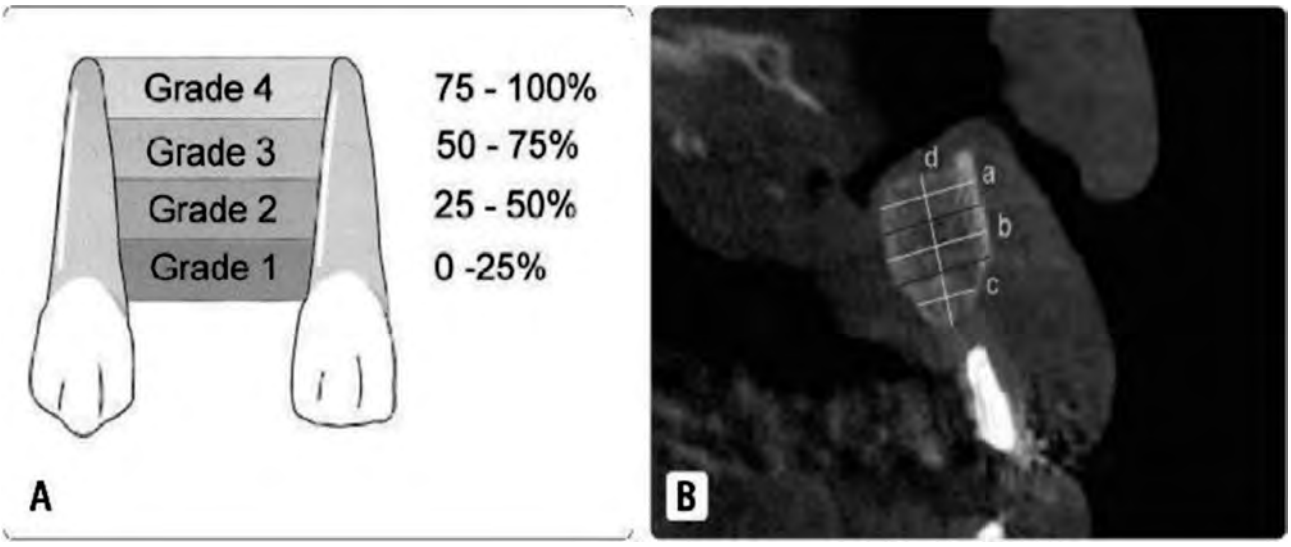

Figure 7. Evaluation bone formation. A. Using periapical radiograph with Enermark scale. B. Using cone beam computed tomography (CBCT).

2.4. Assessment criteria for secondary alveolar cleft bone grafting

The following parameters were evaluated 7 days and 4 to 6, 12, 18, 24, 36, 48 and 96 months after alveolar bone grafting: (1) Soft tissue evaluation (dehiscence and infection), (2) fistula evaluation, (3) bone formation, and (4) implant health.

a.Soft tissue evaluation: was considered as good with pink mucosa, dry, tight flap, as average with the presence of dehiscence but no graft exposure and bad with the sign of infection, dehiscence or bone graft exposure.

b.Fistula evaluation: showed the closed or unclosed fistula.

c. *Bone formation* was evaluated by periapical radiographs using Enermark scale and by Cone Beam CT. Periapical radiographs were obtained using the par- alleling technique before alveolar bone grafting and at each follow-up visit. Enermark scale was used to evaluate bone bridge radiographically with the scores of 1 to 4, which represented the amount of bone fill in the grafted site (Figure 8A). Scores 1 and 2 were considered as successful, score 3 was suggested as partial failure, and score 4 was indicated as complete failure. Cone Beam CT were obtained with the surgical stent in which a gutta-percha was placed vertically along the potential axis of the final restoration. The images were imported into an imaging program (EasyDent V4 Viewer; Vatech, Suwon, Korea) to determine suitable graft dimensions for implant placement. The height which marked as d in Figure 8B was measured from the lowest point to the highest point of the graft. The width was calculated by averaging the buccolingual measurements of the apical, middle, and coronal one-thirds of the graft (marked as a, b, and c, respectively in Figure 8B). It's assumed that standard implants of 10 mm length would be biomechanically sound in the lateral incisor region, required grafted bone for implant placement was at least 7 mm height and 4 mm width.

d.Implant evaluation: included implant osseointegration and esthetic of implant prosthesis. Implant osseointegration was evaluated by Misch's criteria through 4 clinical groups. The successful group was determined as no pain or tenderness during function, no mobility, no history of exudate, and the crestal bone showed a loss of < 2.0 mm on radio-graphs. The satisfactory group was determined as no pain or tenderness during function, no mobility, no history of exudate, and the crestal bone showed a loss of from 2 to 4 mm on radiographs.

Figure 8. Postoperative treatment outcome on radiography (A) clinical alveolar cleft. (B) Bone formation after alveolar bone grafting. (C) Bone volume before implant placement. (D) Dental implant placement on periapical radiography. (E) Dental implant placement on CBCT. (F) Dental implant after 96 months' follow-up on CBCT.

However, compromised group was determined as sensitivity and history of exudates, but no mobility, and bone loss >4 mm (less than half the length of the implant) on radiographs. Lastly, all of the following were observed in the failure group, including: pain during function, mobility, uncontrolled exudate, and radiographic bone loss more than half the length of the implant or loss of the implant. The esthetic of implant prosthesis was evaluated following pink esthetic score (PES) and white esthetic score (WES) based on Belser's standard (2009). The pink esthetic score assesses the soft tissue condition around the implant through 5 factors compared to the contralateral tooth: mesial papilla, distal papilla, curvature of the facial mucosa, height of the facial mucosa margin, soft tissue color and texture. White esthetic score presents the esthetic of the implant restoration with 5 parameters in comparison with the contralateral reference tooth: general tooth form, volume of the clinical crown; color, surface texture and other characterization.

A maximum total score WES and PES of more than 12 was set for being esthetically successful, a score of 12 for clinical acceptance and a score of under 12 for esthetical failure. Degree of patient satisfaction was assessed by the score of 1 to 9 with a score of 1, 2, 3 for unsatisfactory, a score of 4, 5, 6 for satisfactory and a score of 7, 8, 9 for above satisfactory [7].

2.5. Outcome evaluation

The mean age before bone grafting was 21.28 years (range, 16 - 3 years). The mean follow-up period was 63.3 months (range from 18 to 96 months). Evaluating criteria of bone grafting for alveolar cleft included flap status, fistula status, bone formation and implant health.

2.5.1. Soft tissue evaluation

After seven days' post-surgery, good healing was recorded in 29 cases (90.6%). Wound dehiscences occurred in three patients (9.4%), which resulted in a partial loss of bone. But the region healed uneventfully after exfoliation of small bone fragments. After 4 to 6 months, 100% of cases showed good mucosal healing.

2.5.2. Fistula evaluation

After seven days' post-surgery, complete closure of the oronasal fistula was achieved in all 32 patients.

2.5.3. Result of bone formation using Enermark scale

After 4 to 6 months' follow-up, the bone formation score I was 90.6% in 29 patients and score III was 9.4% in 3 patients. Score III were insufficient bone for dental implant so these 3 patients were indicated fixed bridge and removed from the follow-up. At 12 months' follow-up, there was no change in 29 patients scored I. After 18 months postoperatively, 1 patient appeared bone resorption which dropped from score I to score II. However, score I and score II were considered as successful by Enermark, so the total success rate of the graft was 90.6% (including 3 cases of score III). Bone bridge formation in the cleft at the point of 18 months compared with the point of 6 and 12 months showed no statistically significant differences ($p > 0.05$). Thus, implant placement can limit bone resorption. After 96 months, only 15 patients with total 18 implant were still remained follow-up presented Enermark score I.

2.5.4. Result of bone formation using CT Cone Beam

On axial CT at 6 months postoperatively, the

mean apical-coronal distance of 11.4.0 ± 2.4 mm and the mean buccal-lingual distance of 6.1 ± 1.0 mm was reported. According to Renouard's standard, 29 of 32 alveolar clefts (90.6%) displayed the bone bridge formation enable for implant placement. Three clefts (9.4%) showed insufficient bone for implant placement which indicated fixed bridge restorations.

2.5.5. Result of implant placement

Total of 32 implants were placed, of which 31 implants were of size 3.8 x 10 mm and 1 implant was 3.8 x 12 mm. 3/32 patients received 2 implants place- ment, 26/32 patients received 1 implant placement. Initial implant stability: over 35 N/cm2 in 12.4% of implants, 20–35 N/cm2 in 43.8% and 15-20 N/cm2 in 43.8%. Additional bone graft during implant placement were performed in all 32 patients, in which 90.6% used GBR technique and 9.4% used ring bone technique.

2.5.6. Result of implant osseointegration

After 12 months' follow-up, 100% implants were successful (Table 2). However, after 18 months, 96.9% (31 implants) were successful, 3.1% (1 implant) appearing with 2 mm bone loss making it become satisfactory survival, no implant failure. The total survival of implants in good function were still 100%. The survival rate at the point of 12 had no significant difference compared to the point of 18 months ($p > 0.05$). After 90 months, all 18 implants were recorded success in 15 patients remained follow-up.

2.5.7. Esthetic result of the prostheses on implant

Esthetic result followed pink esthetic score (PES) and white esthetic score (WES) based on Belser's standard (2009) [7]. In the follow up of 12 months after implant placement, 18 implant prostheses (56.3%) were esthetical success, 5 prostheses (15.6%) were clinical acceptable and 9 prostheses (28.1%) were esthetical failure. After 90 months implant postoperative, among 15 patients with 18 implants remained follow-up, 15 implant prostheses (83.4%) were esthetical success, 1 prosthesis (5.5%) were clinical acceptable and 2 prostheses (11.1%) were esthetical failure.

2.5.8. Result of degree of patient satisfaction of the prostheses on implant

In the follow up of 12 months after implant placement, 21 patients (72.4%) were above satisfied with their prostheses, 8 patients (27.6%) satisfied and no patients disappointed with their prostheses on implants. After 90 months implant postop- erative, all 15 patients attended follow-up examination reported above satisfied with their prostheses.

3. CONCLUSION

This paper provides a new treatment method for patients with cleft lip and palate defect, not only to recover the function but also to meet the esthetic demand helping patients communicate confidently for community integration. The technique of two iliac cortical bone blocks sandwich has combined the advantages of cortical bone and cancellous bone that limit bone resorption, easily obtain the implant initial stability, rapidly vascularization and quick healing. Therefore, the new proposal technique seemed to be a practical and a feasible solution for the rehabilitation of alveolar cleft.

Acknowledgements

The authors wish to thank the staff of the Nhan Tam Dental Clinic, Ho Chi Minh City, Vietnam.

Conflict of interest
The authors have stated explicitly that there is no conflict of interest in connection with this article.

REFERENCES

[1] Nakamura N. Surgical Strategy for Secondary Correction of Unilateral and Bilateral Cleft Lip-Nose Deformities. *Rhinoplasty*, 5, 57-70, 2011.

[2] Luque-Martín E, Tobella-Camps ML, Rivera-Baró A., "Alveolar graft in the cleft lip and palate patient: Review of 104 cases", *Medicina oral, patologia oral y cirugia buccal*, 19(5), e531-e5e7, 2014.

[3] Cho-Lee GY, García-Díez EM, Nunes RA, Martí-Pagès C, Sieira-Gil R, Rivera-Baró A., "Review of secondary alveolar cleft repair", *Annals of maxillofacial surgery*, 3(1), 46-50, 2013.

[4] McIntyre GT, Devlin MF, "Secondary alveolar bone grafting (CLEFTSiS) 2000-2004". *Cleft Palate Craniofac J*., 47, 66-72, 2010.

[5] Belser UC, Buser D, Hämmerle C, Jung R, Martin WC, Morton D, et al. ITI Treatment Guide: Implant Therapy in the Esthetic Zone – Single-Tooth Replacements, 2007.

[6] Stevens MR, Emam HA, Alaily ME, Sharawy M. Implant bone rings. One-stage three-dimensional bone transplant technique: A case report. *J Oral Implantol*, 36(1), 69- 74, 2010.

[7] Esper L, Sbrana M, Ribeiro I, Siqueira E, Almeida AL. Esthetic analysis of gingival components of smile and degree of satisfaction in individuals with cleft lip and palate. The Cleft palate-craniofacial journal: official publication of the American Cleft Palate-Craniofacial Association, 46, 381-387, 2009.

Kỹ thuật ghép hai mảnh xương vỏ mào chậu trong ghép xương khe hở ổ răng ở bệnh nhân khe hở môi vòm miệng

Võ Văn Nhân và Phạm Nguyên Quân

TÓM TẮT

Mục tiêu: Mô tả chi tiết quy trình và kết quả điều trị của kỹ thuật mới dùng hai khối xương vỏ mào chậu trong ghép xương khe hở ổ răng ở bệnh nhân hở hàm ếch một bên. Đối tượng và phương pháp nghiên cứu: Nghiên cứu tiến cứu 32 bệnh nhân với điều trị ghép xương khe hở ổ răng với kỹ thuật mới ghép hai khối xương vỏ mào chậu và cấy ghép implant. Tiêu chí lựa chọn bệnh nhân là bệnh nhân trên 15 tuổi, bệnh nhân có sức khỏe tốt đảm bảo điều kiện phẫu thuật chưa được ghép xương khe hở ổ răng. Việc nhổ răng được thực hiện trước khi ghép xương 2 tháng nếu cần thiết. Bệnh nhân được ghép xương thì hai muộn cho khe hở ổ răng bằng kỹ thuật mới. Kết quả đánh giá mô mềm, mô xương, tái tạo xương và implant được ghi nhận với thời gian theo dõi là 96 tháng sau ghép xương ổ răng. Kết quả: Sau 4 đến 6 tháng, 100% trường hợp lành thương niêm mạc tốt. 90.6% bệnh nhân có tạo xương loại I (29 bệnh nhân) và 9.4% có tạo xương loại III (3 bệnh nhân).

Tất cả 18 implant đã được tích hợp thành công. Kết luận: Phương pháp điều trị mới được đề xuất cho bệnh nhân khe hở môi vòm miệng không chỉ phục hồi chức năng mà còn đáp ứng nhu cầu thẩm mỹ giúp bệnh nhân tự tin giao tiếp hòa nhập cộng đồng.

Từ khóa: *ghép xương khe hở ổ răng, khe hở môi và vòm miệng, khe hở ổ răng một bên, cấy ghép nha khoa*

Received: 12/09/2022
Revised: 26/10/2022
Accepted for publication: 20/11/2022