Study of the Platelet Rich Fibrin in Alveolar Cleft Bone Graft by Using Cone Beam Computed Tomography

การศึกษาการใช้ไฟบรินที่อุดมไปด้วยเกล็ดเลือดในการปลูกถ่ายกระดูกในรอยแยกเบ้าฟันโดยการใช้ภาพรังสีส่วนตัดอาศัยคอมพิวเตอร์ชนิดโคนบีม

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ABSTRACT

This study aimed to investigate the volume of the platelet rich fibrin (PRF)-combined autogenous bone graft in alveolar cleft. We performed secondary alveolar cleft bone grafting in 9 cleft lip and palate patients. Patients were classified into 2 groups. The study group consisted of 4 patients grafted with autogenous bone and PRF (average age was 10.5 ± 1.7 years). The control group consisted of 5 patients grafted with autogenous bone without PRF (average age was 10.6 ± 2.19 years). The percentage of bone filled in the alveolar gap was evaluated by cone beam computed tomography at 6 months postoperatively comparing to preoperative cleft volume. The results were 74.07 ± 20.28% and 73.44 ± 16.62% in study group and control group, respectively. Mann-Whitney U test showed no statistical significance between both groups.

บทคัดย่อ

งานวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาปริมาตรของการปลูกถ่ายกระดูกในตนเองร่วมกับไฟบรินที่อุดมไปด้วยเกล็ดเลือดในการรักษาผู้ป่วยที่มีรอยแยกเบ้าฟัน โดยศึกษาในผู้ป่วยปากแหว่งและเพดานโหว่ 9 คนที่รับการผ่าตัดปลูกกระดูกในรอยแยกกระดูกเบ้าฟัน แบ่งผู้ป่วยเป็น 2 กลุ่ม กลุ่มศึกษาประกอบด้วยผู้ป่วย 4 รายที่ได้รับการปลูกถ่ายกระดูกร่วมกับไฟบรินที่อุดมไปด้วยเกล็ดเลือด (อายุเฉลี่ย 10.5 ± 1.7 ปี) และกลุ่มควบคุมประกอบด้วยผู้ป่วย 5 รายที่ได้รับการปลูกถ่ายกระดูกโดยไม่ใช้ไฟบรินที่อุดมไปด้วยเกล็ดเลือด (อายุเฉลี่ย 10.6 ± 2.19 ปี) ประเมินร้อยละปริมาตรของกระดูกในรอยแยกเบ้าฟันหลังจากผ่าตัด 6 เดือนเปรียบเทียบกับปริมาตรของรอยแยกเบ้าฟันก่อนผ่าตัดโดยใช้ภาพรังสีคอมพิวเตอร์ชนิดโคนบีม พบว่ากระดูกในรอยแยกเบ้าฟันมีปริมาตรร้อยละ 74.07 ± 20.28 และ 73.44 ± 16.62 ในกลุ่มศึกษาและกลุ่มควบคุมตามลำดับ จากการทดสอบแมนน์-วิทนีย์ ยู พบว่าไม่มีความแตกต่างกันระหว่าง 2 กลุ่ม

Key Words: Platelet rich fibrin (PRF), Alveolar cleft bone grafting, Cone beam computed tomography (CBCT)
คำสำคัญ: ไฟบรินที่อุดมไปด้วยเกล็ดเลือด การปลูกกระดูกรอยแยกเบ้าฟัน ภาพรังสีคอมพิวเตอร์ชนิดโคนบีม

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Introduction

Secondary bone grafting in the alveolar cleft site was first described by Boyne & Sands in 1972. This is one of esstential procedures in the management of cleft lip & palate patients. The benefits of placing bone in the alveolar cleft are not only closure the oronasal fistula but also restoration the continuity and stability of the alveolus and the maxilla, prevention collapse of the alveolar segments, support the nasal alar, preservation the health of dentition, provision bone for eruption of canine or lateral incisor and improving craniofacial development (Kalaaji, Friede, 1994), (Teja, Omnell, 1992). However, to achieve the ultimate goal of provision bone support for spontaneous eruption of the adjacent teeth especially canine or lateral incisor, this technique is performed in mixed dentition (Bergland, Abyholm, 1986), (Brattstrom, Larson, Semb, 1992).

Autogenous bone is the most preferred because of the osteoinductive, osteogenic and osteoconductive properties and less risk of immunological reaction and transmission of the diseases. The autogenous bone can be harvested from iliac crest (Boyne, 1972), calvarial bone (P.T, 1992), rib (Rosenstein, et al., 1982) or tibia (Kalaaji, Elande, Friede, 2001). Cancellous bone is superior to cortical or osteochondral bone due to more osteoprogenitor cells (Borstlap, Freihofer, Kuijpers-Jagtman, 1990). The success of alveolar bone grafting depends on many factors including type of cleft lip and palate, type of grafted bone, timing of procedure, duration of surgery, surgical technique, amount of initial defect, host immune status, physiological stress and growth factors.

Platelet rich fibrin (PRF) is a new generation biomaterial. The preparation process is uncomplicated and no chemical agent is needed. Moreover, the autologous blood collected at the time of surgery eliminates the concerns about disease transmission and immunologic reactions, which are associated with allogenic or xenogenic preparations (Marx, Eichstaedt, et al., 1998). It has many growth factors favorable to healing and immunity including platelet-derived growth factor (PDGF), vascular endothelial growth factor (VEGF), and fibroblast growth factor-basic (FGFb) (Choukroun, Simonpieri, et al., 2006). These growth factors are able to stimulate bone regeneration. From these benefits, PRF is used in many dental treatments such as bone grafting, dental implant and periodontal regeneration. However, the advantage of PRF in alveolar cleft bone graft is not reported. Bone resorption may occur after alveolar cleft bone grafting. Thus, we hypothesized that alveolar cleft bone grafting using PRF may has higher successful healing rate by reducing bone resorption volume.

In evaluation the success of bone grafting, the radiograph is used along with the clinical outcome. Although the conventional radiograph is commonly used for evaluation the success of bone graft. It displays only two dimensions and fails to evaluate the volume, morphology and bony architecture. Moreover, the two dimensional radiograph was under- or over-estimation when compared with computerized tomography (CT) scan which displays three dimensions (Rosenstein, Dado, Vinson, Alder, 1997). The disadvantages of conventional radiograph also include distortion, lack of the reliable landmarks and superimposition of the nearby structures (Van der Meji, Prahl-Andersen, Valk, Kostense, Tuinzing, 2001). Nowadays, CT plays more roles in many fields including oral and maxillofacial surgery. Cone beam CT (CBCT) is used in this study due to the advantages

over conventional radiograph and other type of CT. CBCT has total radiation approximately 20% of conventional CTs. It displays three dimensions of alveolar bone cleft defect and provides the estimation of volume of bone graft needed. Moreover, the actual dimension of grafted area can be achieved.

The purpose of this study is to evaluate the outcome of PRF on alveolar cleft bone grafting using autogenous iliac cancellous bone.

Materials and methods

We performed secondary iliac cancellous bone grafting in 9 cleft lip & palate patients. In study group, we treated particulate cancellous bone graft with PRF in 4 patients (average age was 10.5 ± 1.7 years). In control group, we treated particulate cancellous bone graft without PRF in 5 patients (average age was 10.6 ± 2.19 years). The data was collected at Faculty of Dentistry, Chulalongkorn University (Bangkok, Thailand).

All patients were provided informed consent which was approved by the ethic committee, Faculty of Dentistry, Chulalongkorn University (No. 030/ 2012).

PRF preparation

PRF preparation was performed at the operating room, Dental Hospital, Faculty of Dentistry, Chulalongkorn University.

PRF was prepared at the time patient receiving operation. Approximately 20 ml of autologous blood was drawn from anti-cubital vein before giving any drugs intravenously. Then, it was divided into 2 tubes and immediately centrifuged by automatic blood centrifugation (Dynamica Velocity 14R centrifuge®, Victoria, Australia) at 2500 rpm, 25°c for 10 minutes. The PRF from one tube was mixed with the particulate cancellous bone and marrow (PCBM) harvested from iliac crest and the other tube was left to form PRF membranes.

Surgical procedures

The surgical procedure for alveolar cleft bone grafting was performed following a standard procedure. Briefly, the incision was made along the alveolar cleft, the gingival mucoperiosteal flaps were reflected into the nasal side and the oral side. The nostril floor was closed in the water-tight manner. The alveolar space was filled with PCBM harvested from the anterior ridge of the iliac crest. In the study group, PCBM mixed with PRF was placed into the cleft and covered with a PRF membrane (Figure 1). In the control group, only PCBM was placed. Then the flaps of oral side were closed in the tension-free, water-tight manner to prevent oral fluid leakage into the grafted area.

Figure 1 Surgical procedures

Computed tomographic evaluation

Computed tomography (CT) scan was taken before and 6 months after alveolar cleft bone grafting at Department of Radiology, Faculty of Dentistry, Chulalongkorn University by Dentomaxillofacial Cone-beam X-ray CT system (Hitachi CB MercuRay, Hitachi Medical Corporation, Tokyo, Japan) & Imager

(Fuji DryPix 3000, FUJIFILM Corporation, Japan). Each patient received a computerized axial tomography of the skull. Patient positioning was standardized with the maxillary alveolar crest parallel to the plane of the scan.

The volume of alveolar cleft defect before operation was recorded (Figure 2). The bone in the cleft site at 6 months after surgery was measured (Figure 3). The percentage of bone in the alveolar cleft was a ratio of bone volume in the gap and pre-operative cleft volume. The volume was calculated by area multiply with height of alveolar cleft bone in every 2 mm. intervals from alveolar crest to floor of nose in axial view, using CBworks 2.12 software (Hitachi, Japan).

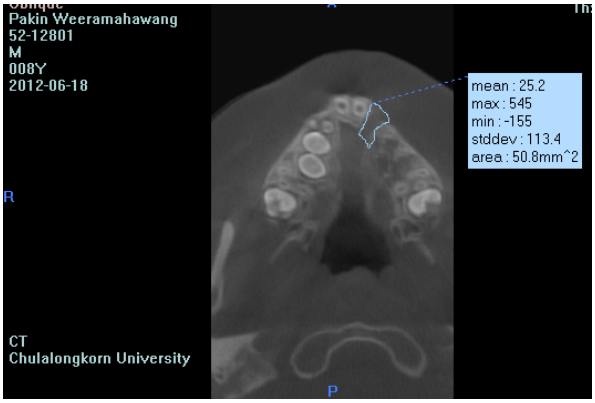

Figure 2 Pre-operative alveolar cleft defect

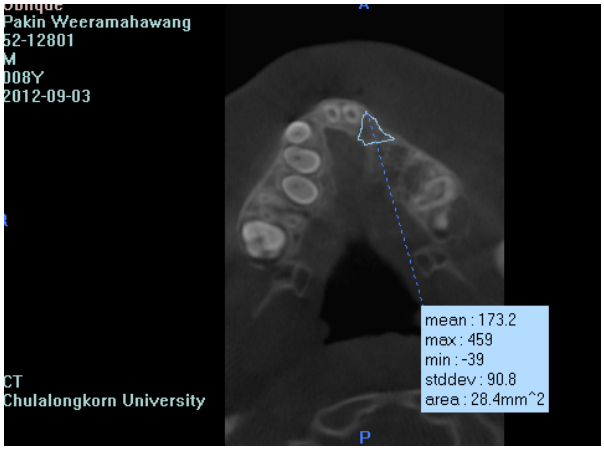

Figure 3 Post-operative bone forming at 6 months

Results

All patients did not have any complications after surgery. In control group, the minimum percentage of bone-filled volume was 52.79% and the maximum was 90.28%. The average was 73.44 ± 16.62%. In study group, the minimum percentage of bone-filled volume was 48.51% and the maximum was 93.39%. The average was 74.07 ± 20.28% (Table 1). Mann-Whitney U test showed no statistical significance (P = 1.00) between both groups.

Table 1 Age, volume of alveolar cleft, and volume of bone forming in each case

Patient	Group	Age (years)	Cleft volume (mm^3)	Bone-filled volume (mm^3)
1	PCBM	14	688.8	489.51 (76.07%)
2	PCBM	10	431.97	389.97 (90.28%)
3	PCBM	11	376.45	339.36 (90.15%)
4	PCBM	8	433.95	229.11 (52.79%)
5	PCBM	10	400.26	251.79 (62.91%)
6	PCBM+PRF	9	547.05	369.18 (67.49%)
7	PCBM+PRF	13	298.41	278.67 (93.39%)
8	PCBM+PRF	10	314.16	273.00 (86.90%)
9	PCBM+PRF	10	375.74	182.28 (48.51%)

Discussion and conclusions

Secondary alveolar cleft bone grafting is an important treatment in cleft lip and palate. The bone healing volume is necessary for success of surgical procedure and further orthodontic treatment. The outcome of alveolar cleft bone grafting was evaluated by clinical and radiological examination. CBCT provides better diagnostic and quantitative information on periodontal bone levels in three dimensions than conventional radiography (Mol, 2008). Therefore, CBCT was used in this study for evaluating the cleft size, volume of bone graft needed and healing after alveolar cleft bone grafting. In this study, we examined the result at 6 months postoperative. We did not performed CBCT immediately postoperation due to the concerning of radiation exposure to patients.

Due to the richness of growth factors favorable to healing of PRF, we were interested in the benefit of PRF on bone graft healing. The outcome of grafted bone was measured by volume of filled bone in alveolar cleft at the 6th month after surgical procedures. However, we needed for further investigation on the effect of PRF improve in bone healing rate. Although the bone filled in the cleft showed no statistical difference between study group and control group, PRF aided in handling the particulate bone. After mixing the PRF to the harvested PCBM, the bone was more aggregate and resilient.

This study had many limitations including time, cost, and small sample size. We need further investigations about treated alveolar cleft bone grafting with PRF in long term follow up and more samples.

PRF benefits in handling particulate bone for grafting. The larger sample size is needed for evaluation the effect of PRF in success of bone graft.

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