Alveolar Cleft Reconstruction Using Different Grafting Techniques

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Abstract

BACKGROUND: Cleft lip and palate CLP is a frequent congenital malformation that manifests in several varieties including unilateral or bilateral anomalies due to either genetic or acquired causes. Alveolar cleft graft ACG remains controversial as regard timing, grafting materials and surgical techniques. The primary goal of alveolar cleft grafting in ACG patients is to provide an intact bony ridge at the cleft site to allow maxillary continuity for teeth eruption, proper orthodontic treatment for dental arch alignment and support for nasal symmetry.

AIM: This study aims to compare different grafting techniques to treat the alveolar cleft defect.

METHODS: This study included 24 cases divided into three groups of patients: Group A was treated with autogenous iliac crest bone; Group B was treated with nano calcium hydroxyapatite with collagen membrane and Group C was treated with tissue engineering method using bone marrow stem cells extract and PRF membrane.

RESULTS: According to clinical and radiographic examination measuring bone density in the CT preoperatively compared to six months postoperatively. Group C with bone marrow stem cells extract showed superior results among all followed by group B, while group A with autogenous iliac crest showed resorption in some cases and gave the least values, in addition to its drawbacks as regard donor site affection with pain & scar formation.

CONCLUSION: Bone substitutes as Nano calcium hydroxyapatite and bone marrow stem cells extract showed to be reliable methods for bone grafting than autogenous iliac crest.

Introduction

The alveolar cleft is a bony defect present in 75 % of CLP patients. Repair of the alveolar cleft is mandatory for both function and esthetics especially in syndromic patients with genetic malformations. Although secondary ACG is commonly accepted for these patients, controversy remains regarding the surgical technique and type of grafting material used [1, 2, 3]. A primary alveolar cleft repair usually takes place at an early age of life. Secondary alveolar bone grafting for patients with a cleft involving maxillary alveolus was first advocated by Boyne and Sands in 1972 [4]. The grafting procedures are usually taken around the age of 9-12 years by dental development, most notably at the cleft side of permanent canine as stated by Bergland et al., 1986 [5, 6]. Bone grafting can be performed using either autogenous bone or allogenic bone substitutes. Autogenous bone graft harvested from the iliac crest or rib graft with bone morphogenic proteins BMP has shown success rates. It supports the tooth in the alveolar arch and establish nasal bone morphology and ensures the stability of orthodontic treatment [7]. There are several benefits of bone grafting in patients with alveolar clefts, 1: to obtain arch continuity, which is a universal goal in cleft management. 2: to maximise bone support for dentition. 3: to stabilise the maxillary segments after orthodontic treatment, 4: to eliminate the oronasal...
Methods

This study included twenty-four patients with unilateral alveolar clefts who were randomly selected from OroDental Genetics clinic at National Research Center and Oral Surgery clinic at Faculty of Oral & Dental Medicine Al Azhar University. The sample was divided into 3 groups with different grafting techniques each containing 8 patients.

Group A: Included 8 patients who were treated with autogenous bone graft harvested from the iliac crest.

Group B: included 8 patients who were treated with GBR graft of nano calcium hydroxylapatite and collagen membrane.

Group C: included 8 patients who were treated with tissue engineering of bone marrow stem cells extract with the addition of PRP growth factors.

All patients were informed about all the details of the surgery & signed consent. Ethical approval of the scientific committee at the National Research Center was obtained. Preoperative patients preparation included clinical photographs introraorally as well as extra orally. Also digital radiographs including panoramic x-rays and multi slice CT measuring the size of the defect. Medical history was recorded excluding any systemic diseases. Blood investigations were made prior to each surgery including hemoglobin level, bleeding profile (bleeding time, clotting time & prothrombin time), Kidney functions (Urea & Creatinine), liver functions (SGOT & SGPT), blood sugar, ECG electrocardiogram and chest examination for each patient.

Figure 1: Iliac crest technique (left); Bone marrow stem cells trocar (right)

Surgical procedures: Under GA with full aseptic conditions. A full mucoperiosteal flap was reflected from first premolar region to the central incisor. Separation of oral and nasal layers and closure of fistula was done.

Figure 2: Nano calcium & collagen (left); PRP centrifuge (right)

Group A: Superior anterior iliac spine approach incision at the pelvis with trocar bone particles harvesting minimal invasive rather than traditional chisels and osteotome method. Bone
crushed and placed into the cleft site Figure 1.

**Group B:** 2 gm of hydroxyapatite powder was placed on the collagen membrane and placed into the defect site Figure 2.

**Group C:** Stem cells extracted from bone marrow aspirated from iliac crest using a biopsy needle. PRP obtained by citrated 10 cc syringe after being centrifuged for 15 minutes with 2500 rpm speed to separate the plasma portion rich with growth factors and mixed with bone marrow cells aspirate and packed into cleft site Figure 3.

**Figure 3:** Alveolar cleft defect (left); Alveolar cleft grafting (right)

Following the surgery, all patients were prescribed proper antibiotics, analgesics and anti-inflammatory with oral hygiene instructions and soft food diet. Postoperative clinical evaluation (Figure 4) and radiographic evaluation after 6 months with panoramic x rays (Figure 5) and measuring bone density at graft site from CT and comparing it to the normal side (Figure 6). All data were subjected to statistical analysis.

**Figure 4:** Preoperative cleft site (left); Postoperative cleft site (right)

**Results**

This study included twenty-four patients suffering from unilateral cleft and needed alveolar cleft grafting. Group A patients were grafted by autogenous bone harvested from the iliac crest. Group B patients were grafted by nano calcium hydroxyapatite particles and collagen membrane. Group C patients were grafted by bone marrow mesenchymal stem cells extract with platelet-rich plasma PRP membrane as a scaffold. Group C showed superior results with Mean ± SD 242.4 ± 47.8 with statistically highly significant P value < 0.001** followed by group B with Mean ± SD 144.6 ± 51.6 with statistically highly significant P value < 0.00 ** then group A with Mean ± SD 92.5 ± 35.8 and statistically significant P value 0.033* Table 1. Methods of the evaluation were clinically Figure (7 and 8) and radiographically preoperatively and six months postoperatively Figure (9 and 10) using panoramic x-ray and CT Figure (11 and 12).

**Figure 6:** Preoperative CT (left); Postoperative CT (right)

Bone density was measured in the normal noncleft side and compared to the grafted cleft side in Housefield unit HU. Group C grafted side mean ± SD 618 ± 60.2 compared to normal side mean ± SD 375.6 ± 67.9 with P-value statistically highly significant < 0.001 **. Group B grafted side Mean ± SD 539.9 ± 84.5 compared to normal side with mean ± SD 395.3 ± 65.9 with P-value statistically significant < 0.001* And Group A grafted side mean ± SD 461.0 ± 66.3 compared to normal side mean ± SD 368.5 ± 68.3 with P-value highly significant < 0.001* Table 2. Accordingly, the use of bone substitute materials proved to be a reliable method rather than donor site
affecting iliac with scar and pain as well as patient’s gait problems in case of autogenous bone. Allgrafted patients procedures went uneventful. However, group A showed some bone resorption later on while groups B & C showed bone regeneration due to osteoinductive properties of the graft material used.

Table 1: Comparison among 24 cases undergone different methods of grafting according to the mean difference of bone densities of grafted side and normal side

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|---------------------------------------------------------------|
|                                      | Group A                      | Group B                      | Group C                      | P       |
| Mean ± SD                   | 92.5 ± 35.8                 | 144.6 ± 51.6                 | 242.4 ± 47.8                | < 0.001** |
| Median                      | 91.5                        | 132                         | 251.5                       |< 0.001**$ |
| P value                     | 0.033*                      | < 0.001**                   | < 0.001**                   |         |

$p$ value between group AMB between B&C between A&C; **statistically significant difference $p < 0.05$; **statistically highly significant difference $p < 0.01$.

Group A: Autogenous graft of iliac crest bone.

Group B: Graft with Nano calcium hydroxylapatite and collagen membrane.

Group C: Graft with bone marrow stem cells extract and PRF.

Table 2: Comparison between bone density in the normal side and grafted side in 24 cases

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|---------------------------------------------------------------------------------------------|
|                                      | Grafted area Mean ± SD | Normal side Mean ± SD | P       |
| Autogenous graft of iliac crest bone        | 461.9 ± 66.3            | 368.5 ± 68.3            | < 0.001* |
| Nano Ca hydroxyapatite and collagen membrane | 539.9 ± 84.5            | 395.3 ± 65.9            | < 0.001* |
| Bone marrow stem cells extract with PRF     | 618.0 ± 60.2            | 375.6 ± 67.9            | < 0.001** |

Statistically highly significant difference $p < 0.01$.

Discussion

Cleft lip and palate is a congenital problem that happens for 1:700 child at birth according to UK studies. The alveolar cleft is a bony defect present in 75 % of CLP patients [1]. Repair of the alveolar cleft is mandatory for both function and esthetics. A primary alveolar cleft repair usually takes place at an early age of life. Secondary alveolar bone grafting for patients with a cleft involving maxillary alveolus was first advocated by Boyne and Sands in 1972 [4]. Secondary Alveolar bone grafting between the ages of 9-11 years is a routine procedure for children with cleft involving the alveolus [19]. The main advantages can be summarised as follows: stabilisation of the maxillary arch, allowing eruption of the canine and sometimes the lateral incisor, providing bony support for adjacent teeth, oroantral fistula closure and raising the alar base [20]. Von Eisenberg in 1901 & Lexer in 1908 was the first to use autogenous bone graft in the maxillary alveolar cleft. Iliac crest donor site seems to be the most preferred by surgeons however there are possible complications from the iliac crest as excessive blood loss, haematoma, delayed wound healing, pain lasting for two weeks to two months, and painful scars under belts or clothing and hypoesthesia or anaesthesia as observed by patients in the first group A. Radiographic evaluation showed that after 6 months of follow up bone volume loss in some cases. According to Masashi et al., [21] who compared the use of autogenous bone grafting versus using hydroxyl appliance bone combined with collagen membrane in 15 patients and observed that the there was no difference in radiographic results as regard the bone volume formed postoperatively while after 6 months postoperatively he concluded that the group grafted with iliac crest resulted in bone resorption while the group grafted with hydroxylapatite particles resulted in bone formation with no doner site complications with matching results to our current research in the second group B patients. The present study also concluded that using nano hydroxyl apatite on collagen sponge in alveolar cleft grafting was more successful and the same finding occurred with Al Ahmady HH et al., [22] who studied the merits of nano calcium hydroxyapatite with 90% success rate over the autologous iliac crest bone grafting with 70 % success rate in 20 patients divided into two groups during a period of 12 months follow up radiographically. The third group C in this study that was treated with bone marrow mesenchymal stem cells along with PRF membrane showed promising outcome according to its osteoinductive and osteoconductive properties in addition to overcoming the draw backs of standard autogenous method of bone grafting. Bajestan MN et al., [23] also proved that stem cell therapy with bone marrow derived cells can promote regeneration of bone in 18 cleft and trauma patients. He showed that the ability of stem cells to treat large alveolar cleft defects is safe. Our findings in the present study showed the best outcome in group C patients who were treated with tissue engineering technology combined with PRF method [1] as Choukran [15] who stated all the merits of the platelet-derived growth factors.

In conclusion, bone substitutes as Nano calcium hydroxylapatite and bone marrow stem cells extract showed to be reliable methods for bone grafting than autogenous iliac crest.

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