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REPAIR OF ALVEOLAR CLEFT DEFECTS USING BONE MARROW ASPIRATE IN A RESORBABLE MATRIX (CLINICAL AND RADIOGRAPHIC STUDY)

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ABSTRACT

The aim of this study is to evaluate the use of the bone marrow aspirate in a resorbable matrix for repair of alveolar cleft defects together with evaluating its morbidity at the iliac crest donor site. The study was carried on twelve patients with alveolar cleft, comparing the post operatative results of autogenous iliac crest bone graft and bone marrow aspirate on a collagen carrier as an alternative grafting material with minimum morbidity. The twelve patients were divided into two equal groups: group A were grafted with autogenous iliac crest as a standardized control grafting material, while group B were grafted with the bone marrow aspirate on a collagen carrier. Based on our clinical results, we believe that bone marrow aspirate with a resorbable collagen carrier is a promising grafting material for reconstruction of the alveolar cleft defects in young patients, with the best results regarding the donor site morbidity allowing patients returning to normal function within an acceptable time frame and with an aesthetically acceptable donor site scar.

KEYWORDS: Alveolar cleft, marrow aspirate, iliac crest. stem-cell, collagen.

INTRODUCTION

Alveolar cleft is one of the common disorders managed by maxillofacial surgeons, reconstruction of this disorder includes alveolar cleft repair and closure of the associated oronasal fistula.[1] Reconstruction of the alveolar cleft has been a controversial issue since the first reported bone graft series in 1955, there have been hundreds of published reports that have addressed issues of perioperative orthopedics, timing of osteoplasty and types of grafts.[2]

Several objectives for cleft reconstruction including: a united and symmetric maxilla, closure of the oronasal fistula, bony support for the dentition, a morphologically responsive alveolus and osseous support for the nasal alar base and lip. These goals should be the essential factors in selecting techniques and timing for treatment. Proposals for treatment should achieve these objectives without interfering with dentofacial development.[3]

Many sources for bone grafting have been studied. Particulate marrow harvested from the iliac crest represents the standard graft to which other materials are compared since Boyne and Sands first reported on their series of successful secondary osteoplasties. However, harvest of the autogenous iliac crest bone graft has some potentially serious complications, the most common includes donor site morbidity, pain and sensory disturbances.[4]

As a result of these disadvantages, many surgeons have used autologous fresh bone marrow in osteoconductive biomaterials to augment bone formation since it contains osteogenic precursor cells.[5]

PATIENTS AND METHODS

Selection criteria

Twelve patients with alveolar cleft were selected from the outpatient clinic of the Department of Oral and Maxillofacial Surgery, Faculty of Oral and Dental Medicine, Cairo University. Selection of the patients was based on the following criteria: absence of any systemic disorders that may influence the course of wound healing , absence of any blood disorders which might cause complications after the bone marrow aspirate procedures also Syndromic cases were excluded.

Patients Grouping

The patients were divided into two equal groups (six patients for each) according to type of graft intended to be used in the alveolar cleft defect. Group A (control group) were grafted using autogenous anterior iliac crest bone graft, while Group B (study group) were grafted with autogenous bone marrow aspirate obtained from the posterior iliac crest seeded on a collagen sponge carrier.

Preoperative procedures

Included: history taking, exaoral and intraoral examination, patient photograph from various views, Cone beam CT (CBCT) which provided us with a lot of useful data and orthodontic palatal expansion for cases presented with collapsed arch

Operative procedures

Two surgeon teams took part during the operation. One team operated the cleft alveolus and the second team harvested either the iliac crest bone graft from the anterior ilium or the bone marrow aspirate from the posterior ilium.

Postoperative assessment

Clinical assessment

Post operative follow up at both the donor and the alveolar cleft region were evaluated at the intervals of 1 day, 1 week, 3 weeks, 6 weeks and 6 months. This was done in terms of checking the intra oral wound for presence of infection or graft exposure, detection for persistence oro-nasal communications, Other post operative intra oral complications included presence of bleeding and swelling were also recorded. As for the donor site, gait evaluation was done by knowing about when the patient was able to walk without any limp, any sensory disturbance the patient had acquired and finally scar evaluation in his leg, for checking pain intensity, a visual analogue scale (VAS) was used to establish the satisfaction of patients

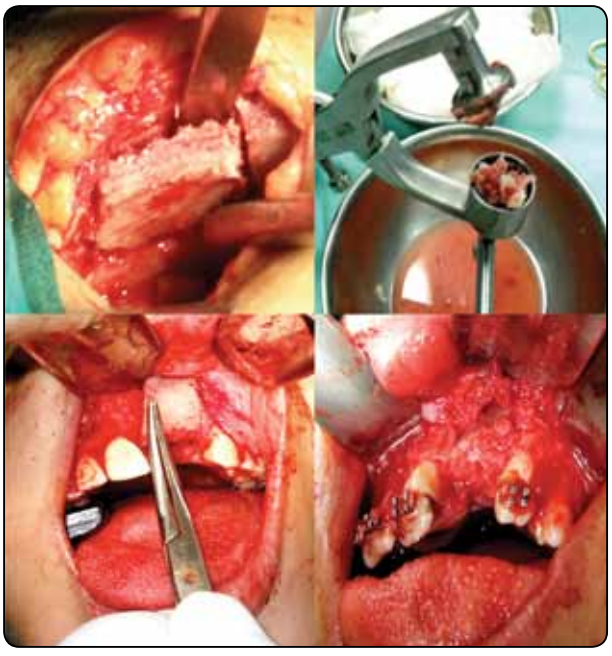

Fig. (1) Photograph showing treatment plan of the control group

Fig. (2) Photograph showing treatment plan of the study group

Radiographic assessment

CBCT was taken immediately post-operative and after 6 months of the operation with the same parameters used in the preoperative state recording the healing process in term of: bone formation bridging the alveolar cleft sides, volume, density and the height of the newly formed bone.

Analysis of data was performed using SPSS 17®.

RESULTS

Alveolar cleft healing process

Wound healing and persistence of the oro-nasal fistula were recorded in both groups: For most of patient of the control (iliac crest) group, the alveolar cleft healing process went straight forward without any major complication, only exposure of the graft was noted after 1 week in one patient together with development of signs of wound dehescince at the cleft site, with symptoms of persistant oro-nasal communication, later the graft became nocrotic and was lost. Regarding the healing process in the study bone marrow aspirate group: 2 cases showed exposure of the collagen carrier in the oral cavity together with formation of granulation tissue in the region of the alveolar cleft after 1 week with symptoms of fluid regurge, it resolved after 6 weeks with no sequelae in one of them but retained in the other preventing the normal healing process. Statistical analysis revealed that the difference in the healing process between the 2 groups was not statistically significant. No abnormal bleeding was observed in any of the 2 groups, post operative swelling occurs in both groups that subsided after 7 to 10 days.

Donor site morbidity

All patients were discharged from the hospital on the same day of the surgery, minimal edema and no evidence of infection was observed in patients of both groups. The control group demonstrated more functional and appearance problems with the hip donor site (in terms of pain, gait and sensory disturbances and tissue scarring) when compared to the study group that revealed a significance decrease in the donor site morbidity

Radiographic results

After 6 months, for the control group, new bone was formed bridging the alveolar cleft gap in all cases except for one patient were there was no bone in the alveolar cleft site indicating failure of the grafting procedure. For the study group, After 6 months, new bone was formed at the cleft site in 5 of the 6 patients of that group. The percentage of bone formation ranged from 58 % to 76% with mean % of 67%± 6.93 for the control group and from 10% to 62 % with mean percentage of 38± 22.6 in the study group. Although the mean density of the grafted cleft site in the study group was lower than that of the control group, statistical analysis revealed that the difference between both groups was not statistically significant.

Comparing the bone height in both groups using Bergland scale, on the reformatted panoramic image

obtained from CBCT, 5 patients of the control group were assigned to the successful groups I and II, while 1 patient was assigned to the insufficient group IV. For the study group, 4 patients were assigned to the successful groups I and II, while 1 patient was assigned to the unfavorable group III and 1 patient for the insufficient group IV, the later had to be re-operated for osteoplasty at a later date

DISCUSSION

In the present study we followed the widely most accepted protocol of the alveolar cleft reconstruction regarding both the time and source of the graft, by doing secondary alveolar bone grafting using autogenous iliac crest bone graft (which is the preferred approach at most centers due to its high success rate)[6] as the standard from which we compare it to our used material.

Mesenchymal Stem Cells can be easily collected by aspiration of bone marrow from the iliac bone and a study on its differentiation to osteoblasts in vitro has been reported. Several investigators have reported that bone marrow cells, when cultured under appropriate conditions, can maintain their viability and are able to differentiate into osteogenic cells.[7] In our studies we used approach to stem-cell-based bone regeneration relying on the direct use of a patient-derived fresh cellular graft prepared at the chair-side, these procedures are relatively convenient for clinicians because they do not require laboratory support or extensive training. When comparing the newly formed bone in the bone marrow aspirate group to that formed in the iliac crest control group after 6 months of doing the operation, the aspirate group has a lower mean volume and density values, but with dramatic decrease in the donor site morbidity.

In our study, we used collagen sponge for its easily shaping property that make it easily fit the shapes of various bone defects with individual difference also it has a structure that prevents leakage of cells. Collagen sponge matrix is degradable at a rate similar to that of the new tissue formation, its large interconnected pores allow for cell incorporation, migration and proliferation for bone formation.[8]

Our results showed reduced postoperative pain with decrease in the morbidity (cosmetic and functional) of the donor site in all aspects in the bone marrow aspirate patients compared with the iliac crest group in nearly all time intervals. Patients of the study group took shorter time to return to their normal life as walking, running and playing sports. Up to our knowledge, no results that conflicts ours regarding the reduced donor site morbidity and pain intensity when the bone marrow aspirate was used as an alternative to an open surgey technique do exists. The radiographic results demonstrate that the bone graft volume and density of the iliac crest group rapidly decreased within the 6 months after grafting, then became stable. This implies that a rapid remodelling process occurred immediately after grafting and maturation of the cortical structure was complete within 6 months.

CONCLUSION

This study supports the view that the iliac crest can still be considered as the gold standard for bone regeneration, but we recommend the use of the bone marrow aspirate with the collagen carrier as an acceptable alternative grafting material in the alveolar cleft patients only in young patients (in the mixed dentition stage) with small sized defects, especially in the case of limited autograft availability or donor site morbidity

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