Original Article - Retrospective Study

Review of secondary alveolar cleft repair

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ABSTRACT

Introduction: The alveolar cleft is a bony defect that is present in 75% of the patients with cleft lip and palate. Although secondary alveolar cleft repair is commonly accepted for these patients, nowadays, controversy still remains regarding the surgical technique, the timing of the surgery, the donor site, and whether the use of allogenic materials improve the outcomes. The purpose of the present review was to evaluate the protocol, the surgical technique and the outcomes in a large population of patients with alveolar clefts that underwent secondary alveolar cleft repair. **Materials and Methods:** A total of 109 procedures in 90 patients with alveolar cleft were identified retrospectively after institutional review board approval was obtained. The patients were treated at a single institution during a period of 10 years (2001-2011). Data were collected regarding demographics, type of cleft, success parameters of the procedure (oronasal fistulae closure, unification of the maxillary segments, eruption and support of anterior teeth, support to the base of the nose, normal ridge form for prosthetic rehabilitation), donor site morbidity, and complications. Pre- and postoperative radiological examination was performed by means of orthopantomogram and computed tomography (CT) scan. **Results:** The average patient age was 14.2 years (range 4–21.3 years). There were 4 right alveolar-lip clefts, 9 left alveolar-lip clefts, 3 bilateral alveolar-lip clefts, 18 right palate-lip clefts, 40 left palate-lip clefts and 16 bilateral palate-lip clefts. All the success parameters were favorable in 87 patients. Iliac crest bone grafts were employed in all cases. There were three bone graft losses. In three cases, allogenic materials used in a first surgery performed in other centers, underwent infection and lacked consolidation. They were removed and substituted by autogenous iliac crest bone graft. **Conclusions:** The use of autogenous iliac crest for secondary alveolar bone grafting achieves all these several objectives: (1) to obtain maxillary arch continuity, (2) to maximize bone support for the dentition, (3) to stabilize the maxillary segments after orthodontic treatment, (4) to eliminate oronasal fistulae, (5) to provide nasal alar cartilage support, (6) to establish ideal alveolar morphology, and (7) to provide available bone with attached soft tissue for future endosteal implant placement in cases where there is a residual dental space. We advocate for the use of a minimal incision to obtain the iliac crest bone graft and for the use of a corticocancellous block of bone in combination with bone chips.

Keywords: Clinical evaluation, retrospective review, secondary alveolar cleft repair

INTRODUCTION

Surgery involving the patient with cleft lip and palate must balance the need for a functional and aesthetic outcome against the potential increased restriction of normal maxillary growth and development. Alveolar bone grafting is a surgical procedure that has become generally accepted for patients with cleft alveolus. The timing of the alveolar bone graft is quite variable but is most often related to the development of the maxillary canine root.

There are several objectives and benefits of bone grafting in patients with alveolar clefts:[1-3] (1) to obtain maxillary arch continuity, which is a universal goal in cleft management; (2) to maximize bone support for the dentition; (3) to stabilize the maxillary segments after orthodontic treatment, especially the mobile primary palate of bilateral clefts; (4) to eliminate oronasal fistulae; (5) to provide nasal alar cartilage support; (6) to establish ideal alveolar morphology; and (6) to provide available bone with attached soft tissue for future endosteal implant placement in cases where there is a residual dental space. In order to achieve these objectives, a sufficient height and volume of bone must be provided. Although secondary alveolar cleft repair is commonly accepted for these patients, nowadays, controversy still remains regarding the surgical technique, the timing of the surgery, the donor site and whether the use of allogenic materials improve the outcomes.

The purpose of the present study was to evaluate the protocol, technique, and results for secondary alveolar bone grafting at a single institution.

MATERIALS AND METHODS

This was a nonrandomized, uncontrolled, retrospective study examining the clinical outcome of a series of secondary alveolar cleft repair performed at the Oral and Maxillofacial Surgery Unit of the Department of Pediatric Surgery at the University Hospital Sant Joan de Déu (Barcelona University), between January 2001 and September 2011.

Patient selection

A retrospective sample of 90 cleft patients was collected from the patient directory of the department, and included all the patients treated with secondary alveolar bone grafting cleft repair, between January 2001 and September 2011.

All patients received and signed a written informed consent form before surgery and were advised that their clinical data will be used for the study. Panoramic radiography and computed tomography (CT) were performed before the procedure in all cases. Postoperative radiographic examination was performed by means of orthopantomography and tomography 2 months postoperatively.

Surgical protocol

1. Secondary alveolar bone grafting was performed after dental alignment and maxillary arch expansion.
2. The retained primary dentition adjacent to the cleft were extracted at least 4 weeks before bone grafting to allow for adequate healing of the keratinized mucosa.
3. Application of clorhexidine gel in the alveolar cleft, three times per day, 2 days before the surgery.
4. Secondary alveolar bone grafting by means of iliac crest autogenous bone grafts in the majority of the cases.
5. Application of clorhexidine gel in the alveolar cleft, three times per day, during 15 days after surgery.
6. Postoperative clinical and radiological evaluations were carried out 15 days and 2 months after the surgical procedure.
7. The orthodontic treatment is taken up again 6 weeks after the surgery.

Surgical technique

The surgical procedures were performed under general anesthesia and nasotracheal intubation.

The pediatric technique used to harvest the anterior iliac crest bone graft was as follows. A minimal skin incision of 2 cm long was placed 1 cm lateral to the iliac crest posterior to the anterior superior iliac spine [Figure 1]. The incision was carried down through the skin, subcutaneous tissue, and fascia, to the cartilagous cap overlying the crest. Meticulous attention was taken to perform minimal stripping of the musculature on the crest. An osteotome was then used to divide the bone along the iliac crest parallel to the long axis of the ridge. Two perpendicular horizontal cuts were made with an osteotome, obtaining a block of corticocancellous bone, including the inner cortex of the iliac crest bone [Figure 1]. Curettes were used to harvest the desired amount of cancellous bone. The surgical site was copiously irrigated, and any potential sources of active bleeding addressed. Microfibrillar collagen was placed into the marrow cavity to aid in hemostasis. The wound was closed in a layered fashion. A local anesthetic subcutaneous infusion pump providing Bupivacaine 0.9% was placed into the wound on the medial aspect of the iliac bone. No drain or pressure dressing was used.

Repair of the alveolar cleft [Figure 2] began with infiltration of 1% articaine with 1:100,000 epinephrine on the buccal and palatal aspect of the anterior maxilla. Two full-thickness mucoperiosteal advancement flaps were initially developed along the gingival sulcus on the labial side extending into the cleft. An incision was made further into the cleft, separating the nasal mucosa from the gingiva. A similar incision was performed on the palate. Careful flap elevation began with a sharp periosteal elevator along the labial surface of the alveolus identifying the piriform aperture. The nasal mucosa was elevated off the lateral wall of the nose and separated from the oral mucosa. The buccal flaps were elevated above the piriform rim. The nasal mucosa was reflected into the nose and the periosteum out of the cleft so that new bone could be grafted onto the bone. A transition was created separating the nasal and oral mucosa, so the bone had proper containment. Closure of the nasal floor mucosa was performed with a simple interrupted 4-0 polyglactin suture. A pyramid-form corticocancellous block of bone was designed to be packed into the cleft, so that the cortical surface of the graft was contacting the nasal floor mucosa. Afterwards, cancellous chips of bone were packed in the little remaining spaces. Keratinized gingival mucosa was advanced from the posterior to provide healthy future periodontum. The oral mucosa closure was tension free with 4-0 polyglactin interrupted suture with reapproximation of the papilla. A horizontal mattress suture was placed over the alveolar ridge where all the incisions come together.

The patients were admitted for 24-hour observation and discharged the following day. The patients were instructed to eat a soft diet for 1 week. The activity restrictions included no kicking balls, lifting weights, school physical education, or swimming. Bathing was allowed after 24 hours. Patients could resume normal activity within 2 weeks.

For the descriptive study of the sample various parameters were considered: (1) age at repair; (2) type of cleft; (3) clinical parameters of success (restoration of the alveolar bone height and width, eruption and periodontal health of the permanent incisor and canine teeth, adequate attached gingiva adjacent to the cleft and successful placement of implant supported restorations); (4) graft consolidation evaluated by means of panoramic radiographs and CT scan; (5) donor site morbidity; (6) adverse events of the graft; and (7) need for further procedures.

Changes in the nasal 3D harmony and morphology were studied choosing 19 patients of our sample (Group 1: Cleft patients that underwent secondary alveolar cleft repair), and comparing the variables with two groups (Group 2: Cleft patients without secondary alveolar cleft repair, 12 patients; Group 3: Control group, 34 patients). For the statistical analysis, dependent variables considered include: Nasal pyramid length, nasal base width, pronasal distance to the sagittal plane (PRN) and subnasal distance to the sagittal plane (SN). These dependent variables were measured studying 18 points, 12 linear measurements, 6 angle measurements, and 4 symmetry parameters. Kruskal–Wallis and Mann–Whitney U tests were performed to compare the groups. The SPSS Inc. IL, USA program, version 15.0 was used for statistical analysis. P value less than 0.05 was considered to be statistically significant.

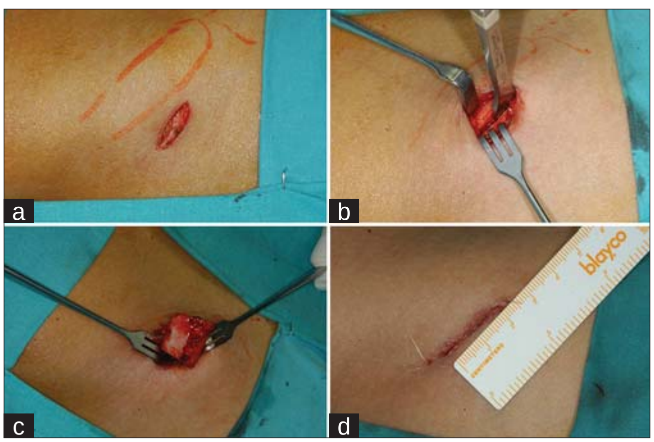

Figure 1: Autogenous iliac crest bone graft harvesting sequence, (a) Skin incision. (b) Horizontal osteotomy, (c) A block of corticocancellous bone is obtained, (d) Conservative 2 cm minimal incision

RESULTS

A total of 109 consecutive secondary alveolar cleft repairs were performed in a series of 90 patients. Median age at repair was 14.2 years (range 4.6-21.8). Of the 90 patients, 19 had bilateral cleft defect, 49 had a left cleft defect, and 22 had a right cleft defect.

In all procedures, autogenous iliac crest bone graft were used. The clinical and radiological parameters of success were regarded as optimal in 87 of the 90 patients [Figures 3 and 4]. Regarding the adverse events of the grafts, there were three losses of the graft, 4 months after the surgical procedure and one case of perialar inflammation that was successfully resolved by means of antibiotics. Regarding donor site morbidity, a scar retouching was needed in one case. Three patients received secondary alveolar bone grafting in other centers, by means of biomaterials. In all those cases there was need for biomaterial substitution due to lack of consolidation, graft infection and lack of eruption of the canines [Figure 5].

Regarding nasal 3D changes after the secondary cleft alveolar repair, no statistically significant differences were found between the three groups in nasal pyramid length. Nasal base measurements were similar in groups 1 and 2 (25.8 and 29.2 mm, respectively) and higher than those in group 3 (22 mm); $P < 0.05$. Regarding nasal symmetry, pronasal, and subnasal distances from the sagittal plane were similar in groups 1 and 3 (PRN 2.7mm/2.4mm; SN 2.2mm/2.1mm; respectively) and resulted higher in group 2 (PRN 4.2mm; SN 3.5mm), $P < 0.05$.

DISCUSSION

Closure of alveolar bone defects is necessary to allow orthodontics to restore a normal alveolar arch, allow dental and occlusal restoration in cleft and palate patients, and allow further orthognathic surgery.[1-5]

Although other sources of autogenous bone have been attempted, iliac bone is most commonly used owing to

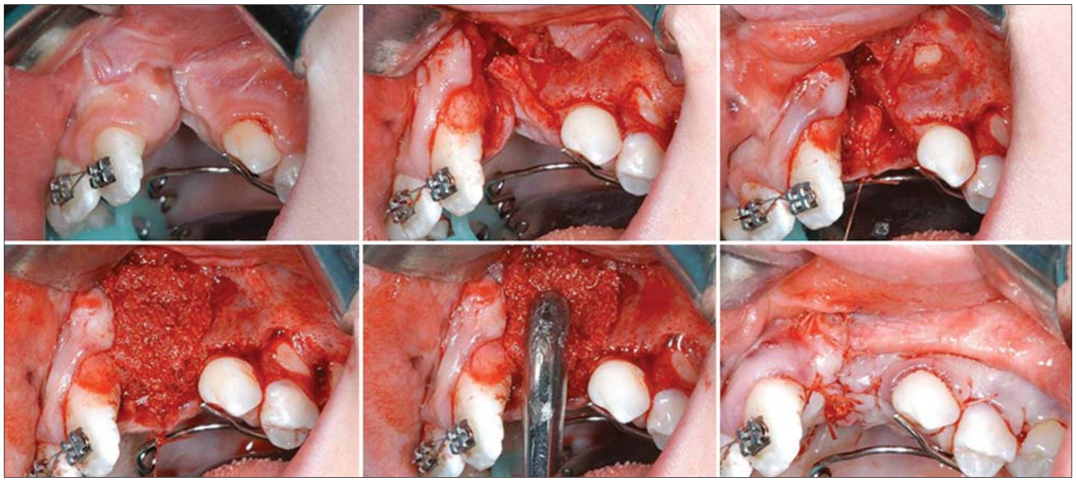

Figure 2: Alveolar cleft repairing sequence

its abundance, ease of access, and superior outcomes.[6-9] The concerns associated with iliac crest harvesting have focused primarily on the possible effects on growth, gait disturbances, hematoma, and donor site morbidity. Most of these complications can be minimized with a careful surgical technique that uses a limited incision, minimal stripping of the musculature on the crest, meticulous hemostasis, carefully layered wound closure with reapproximation of the cartilage cap, adequate postoperative pain control, and early ambulation. Our surgical technique is conservative, and we do not perform aggressive dissection of the periosteum or muscular attachments on the ilium. Regarding the surgical procedure, we advocate for the use of a corticocancellous bone block [Figure 6] to achieve the maximum stability of the graft in the cleft site and complete the procedure by packing little chips of cancellous bone [Figure 2]; instead of using only chips of cancellous bone.

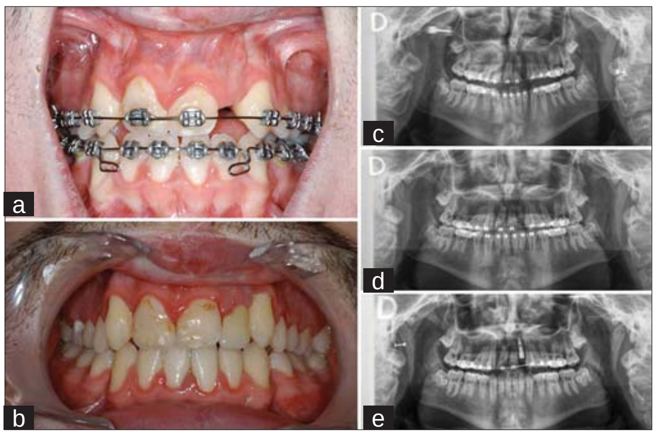

Figure 3: Secondary alveolar cleft bone grafting provides available bone with attached soft tissue for endosteal implant placement, (a) Intraoral image before implant placement, (b) Intraoral image after implant and prosthetic rehabilitation, (c) Panoramic radiograph before secondary alveolar cleft bone grafting, (d) After secondary alveolar cleft bone grafting, (e) After implant placement in the grafted area

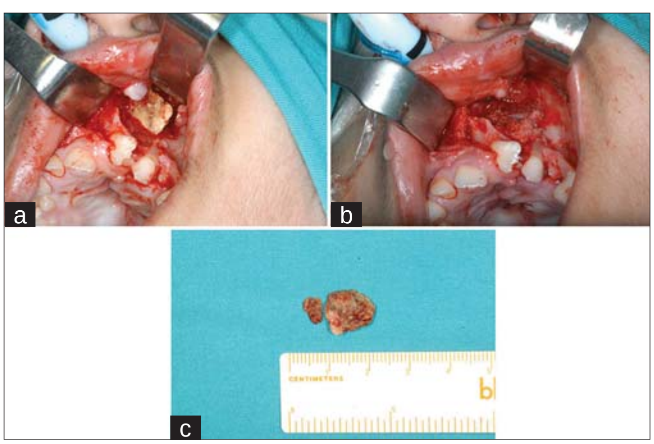

Figure 5: Tricalcium phosphate material used as bone source in a cleft patient, (a) Note the graft infection, lack of consolidation and eruption of the canine, (b) Substitution of the synthetic biomaterial by means of autogenous iliac crest bone, (c) Block of tricalcium phosphate that was removed

With the advent of new biomaterials, which may include or consist of allogenic bone source with or without growth factors, there has been increased consideration for their place in the repair of alveolar clefts, as well as of other dental applications.[10] Our team does not have any experience in the use of biomaterials for secondary alveolar cleft repair. Our experience includes three patients who were first treated in other centers by means of tricalcium phosphate, that presented to our department for reintervention, because of graft infection and lack of canine eruption.

The timing of alveolar bone grafting has traditionally been divided into primary and secondary stages with primary grafting performed after lip repair but before repair of the palate.[11,12] Secondary grafting has been defined as early secondary at 2-5 years, early mixed dentition at 6-8 years, late mixed dentition at 9-12 years, and late secondary grafting if done after the age of 13.[13] Numerous studies have demonstrated greater success rates when grafting before canine eruption compared with delayed grafting.[3,4,13] Earlier grafting has been advocated when the lateral or central incisor is developing in an attempt to prevent eruption into a residual cleft, which could jeopardize the health of the tooth. Often, waiting for canine root development jeopardized the periodontal support of the central and lateral incisors, which collapse into the cleft. When one root surface of the incisor has become exposed, bone reattachment is nearly impossible to achieve.

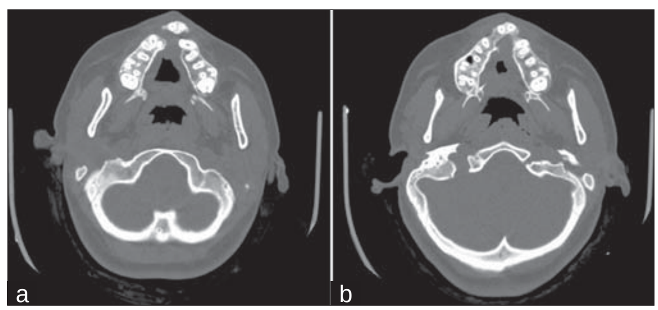

Figure 4: CT scan images in a bilateral alveolar cleft patient, (a) Before secondary alveolar cleft bone grafting, (b) Two months after bone grafting

Figure 6: Pyramidal block of corticocancellous iliac crest bone packed in the alveolar cleft

The factors that contribute to the timing of alveolar cleft grafting, such as chronologic and dental age, vary. However, the state of the developing dentition should be the primary factor to assist in making this decision. Performing the graft before eruption of the permanent canines is generally the latest time to provide optimal outcomes. It is important to stress that the timing of surgery is dependent on the patient' s dental development, not their chronologic age.

One of the main goals of secondary alveolar cleft grafting is to provide nasal alar cartilage support.[1-3] This item has been exhaustively studied in our series. Nasal morphology in cleft patients with secondary alveolar cleft grafting keeps nasal length, increases nasal base width and improves nasal symmetry and aesthetics.

CONCLUSIONS

The use of autogenous iliac crest for secondary alveolar bone grafting achieves all these several objectives: (1) to obtain maxillary arch continuity, (2) to maximize bone support for the dentition, (3) to stabilize the maxillary segments after orthodontic treatment, (4) to eliminate oronasal fistulae, (5) to provide nasal alar cartilage support, (6) to establish ideal alveolar morphology, and (7) to provide available bone with attached soft tissue for future endosteal implant placement in cases where there is a residual dental space. We advocate for the use of a minimal incision to obtain the iliac crest bone graft and for the use of a corticocancellous block of bone in combination with bone chips. We do not include the use of allogenic materials in our protocol.

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