Mid Versus Late Secondary Alveolar Cleft Grafting Using Iliac Crest Corticocancellous Bone Graft

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Abstract

Background Mid-secondary alveolar cleft repair performed at ages 9–12, in the mixed dentition stage, prior to eruption of the permanent canine, is generally accepted as the ideal time for residual alveolar cleft closure in cleft lip and palate cases with a cleft alveolus.

Methods In our study, four cases of mid-secondary and five cases of late-secondary alveolar cleft grafting were carried out using iliac crest corticocancellous bone graft. Clinical defect closure and radiographic bone fill were compared.

Results All the nine cases performed in the two different age groups showed excellent results, clinically, with complete closure of the cleft defect and achievement of continuity of the dental arches. One case was planned for a two-stage procedure owing to the large bilateral maxillary defects. Good bone fill was visualized radiographically in all nine cases.

Conclusion Precise timing for undertaking alveolar cleft repair may not be all that crucial for a successful alveolar cleft grafting procedure.

Keywords Mid-secondary alveolar cleft grafting · Late-secondary alveolar cleft grafting · Iliac crest corticocancellous bone graft

Introduction

In children with cleft lip and palate, cleft in the region of the alveolar process is often left untreated, with cosmetic repair of the lips and nasal deformities and functional repair of the palate taking precedence. Nevertheless, alveolar cleft repair is crucial for closure of an oronasal communication/fistula, thereby eliminating liquid regurgitation into the nose; and for achieving continuity and stability of the alveolar process. It also helps in providing support to the alar base of the nose and establishment of a proper alveolar contour and a normal dental arch preventing significant maxillary segmental collapse, constriction and arch distortion. The graft also provides bone volume for tooth eruption as well as orthodontic movement of teeth by establishing a favorable osseous environment that encourages canine eruption into the arch and provides better periodontal support for teeth adjacent to the cleft [1].

The primary objectives of alveolar cleft grafting are: formation of a continuous and stable dental arch; provision of an osseous environment which encourages canine eruption and is responsive to orthodontic movement of teeth and facilitation of complete dental rehabilitation or prosthodontic reconstruction.

The secondary objectives include: elimination of oronasal fistulae; provision of greater periodontal support for teeth adjacent to the cleft and augmentation of bony support for the lip and alar base [2]. All these objectives depend on satisfactory bone formation within the alveolar cleft defect.

Although the objectives of surgery have been unanimous, the ideal timing for alveolar cleft grafting still remains rather controversial. The timing of graft placement is based more on dental development than on chronological age and may be classified as follows [3]:

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- A. Primary osteoplasty (performed at infancy or in children younger than 2 years of age, along with the lip repair, before accomplishment of palatal closure) [3, 24].
- B. Secondary osteoplasty (performed after palatal closure/repair), which can further be divided into:
  - a. Early secondary, performed between 2 and 8 years of age, before eruption of permanent incisors.
  - b. Mid-secondary, performed at chronological age of 9–12, before which most of the mid-facial growth is complete, during the mixed dentition stage prior to eruption of the cleft canine approximately when its root is half formed.
  - c. Late secondary, performed between 12 and 16 years of age, after eruption of the canine.
  - d. Very late-secondary, performed later than 16 years of age [3, 24].

Of these, ‘mid-secondary repair’ performed between the age of 9 and 12 has been shown by several studies to be ideal [1–4]. This article presents four cases of ‘mid-secondary repair’ of alveolar clefts performed in two 10-year old and two 11-year old males as well as five cases of ‘late secondary repair’ performed in one 13-year old, three 14-year old and one 16-year old with comparable results being achieved in both the groups.

The outcome was based on:

- Eruption of teeth at the cleft site,
- Periodontal support for teeth adjacent to the cleft,
- Alar base support,
- Radiographic appearance of the bone fill and the occlusal level (i.e. septal/alveolar crestal bone height) as well as basal level (i.e. bone at base of pyriform rim) of the newly formed interdental bone at the grafted cleft site, at 6 months post-op.

Materials and Methods

In the mid-secondary group, two 10-year old and two 11-year old males, operated cases of cleft lip and palate, were taken up for closure of the residual alveolar clefts (Figs. 1–11). In all the four cases, the cleft was lateral to the central incisor. The permanent cuspid was congenitally missing in one case and the lateral incisor was missing on the cleft side in remaining three cases (Figs. 1–11). Digital orthopantomograms, maxillary occlusal and intraoral (3 × 4 cm) dental periapical radiographs were taken to assess the volume of the alveolar defect. After oral prophylaxis, dental study models were made and a soft palatal cum occlusal splint was fabricated using a thermoplastic

material to protect and support the grafted area after surgery (Fig. 2). The closure of the alveolar cleft using autogenous corticocancellous bone chips from the iliac crest was performed under GA, which was administered via nasoendotracheal intubation through the non-cleft side nostril. 2 % lignocaine with 1:80,000 adrenaline was infiltrated at the cleft site and into the upper labial vestibule. Sulcular incisions were placed along two teeth adjacent to the cleft on each side. The margins of the cleft were incised and mucoperiosteum reflected exposing the bony cleft (Figs. 3, 7, 9). Mucosa at the base of the pyramidal defect was sutured separating the nasal cavity from the cleft.

The iliac crest graft harvest site was prepared, incision placed lateral to the crest and dissection carried through skin, subcutaneous tissue, Scarpa’s fascia and tensor fascia lata down to the perichondrium overlying the iliac crest. The required volume of cancellous bone was harvested using the trapdoor/trephine technique along with a few cartilaginous pieces from the overlying cartilaginous cap (Fig. 4). Wound was closed in layers after placement of a vacuum assisted closed suction drain. The cartilage pieces were condensed into the cleft cavity first to provide support for the base of the cartilaginous alar base which was depressed (the rationale being to reconstruct like with like), followed by packing of the cancellous bone chips to reconstruct the alveolar defect (Figs. 3, 7, 9). The margins of the mucoperiosteum on either side of the alveolar cleft were brought together after placement of labial relieving incisions and positioned without any tension and a water-tight closure was achieved using 4–0 vicryl sutures. The soft palatal cum occlusal splint was placed to protect the graft. The patients were started on Ryle’s tube feeding 4 h post surgery, and were placed on injectable antibiotics—Inj Cefotaxime 500 mg and Inj Metronidazole 250 mg 8 hourly for 5 days. Post-operative recovery was uneventful in all patients. Oral hygiene was scrupulously maintained by gentle saline and betadine irrigation and regular cleansing of the soft palatal splint. Patients were also administered nasal decongestant drops. On the fifth post operative day, the nasogastric tube was removed and soft diet prescribed. Wound healing at cleft site was excellent. There was minimal pain at the donor site and the patients were ambulatory with a slight limp on the day after the surgery, which resolved within a week. Thus a complete closure of the alveolar cleft and the oronasal communication was achieved. In the first case the first premolar erupted adjacent to the grafted alveolar cleft site post-operatively after a period of 3 months (Fig. 5), in the second case, the lateral incisor erupted through the graft (Fig. 7), in the third case, the lateral incisor on the cleft side was congenitally missing, however, there was good bone fill at the cleft site at the end of 6 months (Fig. 9), and

in the fourth case the left lateral incisor successfully erupted through the grafted bone after a year (Fig. 11). Take up of the graft with achievement of continuity of the dental arches and stability of the alveolar process was confirmed by radiographs after 6 months.

In the late secondary group, the fifth case, a 14-year old male, who had been operated for cleft lip and palate repair, reported with a deficient maxillary development, narrowed transverse dimension of the maxilla, a concave profile, an Angle's CLIII malocclusion and a constricted maxillary arch with anterior and posterior cross bite. A unilateral alveolar cleft between the left maxillary central incisor and canine with a small palatal fistula was also present (Fig. 12). The left lateral incisor was congenitally missing. He was first taken up for orthodontic management, with palatal expansion to correct the posterior cross bite and narrowed maxillary transverse dimension, and a reverse pull headgear to limit forward growth of the mandible (Fig. 12). Correction of the anterior cross bite was achieved using a lower bite plate. The patient was then taken up for surgical correction of the unilateral alveolar cleft (Figs. 13, 14). A similar surgical procedure as enumerated before was performed in this patient. Healing was excellent with complete closure of the oronasal communication as well as simultaneous achievement of an adequate alveolar bone volume and continuity of the dental arch. A partial denture was fabricated to replace the missing lateral incisor (Fig. 14).

Also in the late secondary group, the sixth case, a 14-year old male with bilateral alveolar clefts, underwent palatal expansion with Hyrax screws for correction of diminished transverse dimension of the maxillary arch and the concomitant cross bite (Fig. 15). As the gaps between the maxillary segments were large, a single stage alveolar cleft grafting procedure would have resulted in an incomplete contact of the bone inlay to the underlying maxilla, decreasing the potential for a successful graft. Furthermore, a large intersegmental gap imposes increased tension on the mucosal closure over the bone graft, risking post-operative wound dehiscence and graft exposure [5]. So, cleft repair was planned in two stages—first to build up the deficiency at the base of the alveolus and pyriform rim and also to establish a bony continuity of the arch; and a second stage procedure after a gap of 6 months, to obliterate the palatal fistula and increase the bulk of bone in the alveolar cleft region. The first stage was undertaken successfully (Figs. 16, 17), with alveolar fill radiographically evident at the pyriform rim and alveolar base regions.

In the seventh case (Figs. 18, 19, 20), there was a bilateral alveolar cleft defect in a 13-year old male patient, which was successfully grafted and showed, radiographically, good bone fill at the cleft site at the end of 6 months. An odontome was present near the cleft site which was not

removed at the time of surgery, as this could have caused further loss of alveolar bone in the region.

The eighth and ninth cases (Figs. 21–27), showed alveolar cleft defects between the left central incisor and canine with congenitally missing lateral incisor at the cleft side. In the last case, the cleft side central incisor root stump had to be extracted owing to persistent periapical infection in spite of endodontic therapy. Nevertheless, good bone fill was achieved with successful closure of the palatal fistula.

Results

In all the cases, grafting and repairing the alveolar cleft defect helped to seal off the oroantral communication, restore continuity of the dental arch with simultaneous lifting of the depressed left alar base. Two out of the four cases from the first group had unerupted lateral incisors on the cleft site (Figs. 6, 10), which successfully erupted through the grafted alveolar bone within a year of surgery (Figs. 7, 11). The remaining two cases from this group had a congenitally missing canine (Fig. 1) and a lateral incisor (Fig. 8), respectively, on the cleft side; with a large cleft lateral to the central incisor, which showed radiological evidence of a good bone fill 6 months after the alveolar cleft grafting was undertaken (Fig. 9). In the second group consisting of five cases, patients were already above 12 years when they reported for the alveolar cleft repair. In these cases the canine on the cleft side had already erupted, with the alveolar defect situated between the canine and the central incisor. The lateral incisor on the cleft side was congenitally missing in three of these cases. Alveolar cleft grafting was undertaken nevertheless for all potential benefits like closure of the oronasal and/or palatal fistula, achieving a good alveolar contour, continuity of the dental arch and an adequate bone volume in the cleft region for future dental rehabilitation by prosthesis. Two cases from this group had bilateral cleft defects. In one case orthodontic palatal and maxillary arch expansion preceded the alveolar cleft grafting, with excellent post grafting bone fill 6 months post-operatively. The outcome of the surgery in all the cases treated by late secondary alveolar cleft repair was good, with radiological evidence of good bone fill at the grafted sites comparable to the cases in the previous mid-secondary alveolar cleft repair group.

Nine cases of alveolar cleft grafting were performed in two different age groups. In the first four cases the repair was at mid-secondary stage whereas in the remaining five cases, the repair was late/delayed secondary. However, comparably successful results were obtained in both groups (Figs. 5, 7, 9, 11, 14, 20, 23, 26, 27). There were no complications like infection, extrusion of graft material or dehiscence of flap margins.

Fig. 1 A 10-year old patient with a unilateral alveolar cleft between the left central and lateral incisor

Fig. 2 Soft palatal splint fabricated to protect the graft

Fig. 3 Alveolar cleft site surgically exposed and packed with corticocancellous bone chips

Discussion

Studies have shown that fresh particulate autogenous cancellous bone from the iliac crest is the gold standard for secondary alveolar cleft bone grafting because it supplies

living, immunocompatible bony cells that are essential for osteogenesis and which integrate fully with the maxilla, rapidly transforming into alveolar bone, that responds normally to tooth migration, eruption and orthodontic tooth movement [3, 5, 6]. The number of osteogenic cells/unit

Fig. 4 Autogenous corticocancellous bone graft harvested from iliac crest

Fig. 5 Complete closure of alveolar cleft defect in the 10-year old boy and the erupting first premolar seen lateral to the cleft site at 3 months postoperatively

volume of cancellous bone can be increased further by compacting it (fluff packing), which is thought to increase its reliability even further and is preferable to Cortical and costochondral grafts, which may inhibit tooth eruption [7]. Studies have also shown that inlay endochondral cancellous bone grafts have a higher percentage increase in bone

volume within the defect than cortical membranous or cortical endochondral bone grafts [3]. Use of cancellous bone results in rapid revascularization of the graft over 3 weeks unlike that of cortical bone, which maintains volume by creeping substitution which is a slow process [8].

Alternative donor sites include rib, cranium, tibia, mandibular symphysis and third molar region [9, 10]. The cranial bone has been found to be acceptable but is inferior to the ilium in quality and quantity in most investigations [10]. Delayed ambulation and injury to the epiphyseal region are complications often faced when using the tibia as the donor site in children [11]. The mandibular symphysis and the third molar area provide limited amount of bone available for harvesting [11, 12].

The surgical technique used in both the cases was the advancing buccal gingival and palatal mucoperiosteal flaps as described by Boyne and Sands [23], to access the cleft area, with periosteal flaps from the bony walls of the cleft to repair the nasal floor. After packing the defect with corticocancellous bone, the two labial and two palatal flaps were finally approximated with sutures. This method of closure provides for adequate attached gingiva over the

Fig. 6 Alveolar cleft lateral to the left central incisor in a 11-year old male patient

Fig. 7 Packing of the defect with corticocancellous bone chips. Complete closure of defect with lateral incisor erupting through the grafted area after a year

Fig. 8 An 11-year old patient with a unilateral alveolar cleft between 11 and 13, with missing 12

Fig. 9 Alveolar cleft site grafted and showing good bone fill after 6 months

alveolar process in the cleft region with successful closure of the oronasal fistula, eliminating problems like nasal regurgitation. However the depth of the labial vestibule often reduces following surgery. In larger cleft defects, with large oronasal communication, the amount of tissue available for the advancement of the labial and palatal flaps may be inadequate, as previous surgeries for cleft lip or palate repair often result in fibrosis and scarring in the area. In such cases, where it is not possible to obtain enough advancement of flaps, a rotational flap from the cheek may be used.

Controversy exists over the preferred timing of repair of the alveolar cleft by grafting. Primary osteoplasty, generally is performed after infant orthopedics and primary lip repair and before palatoplasty [3, 13]. A small rib graft is split and introduced through small mucoperiosteal tunnels to be passively placed or onlayed across the labial aspect of the alveolus. Importantly, no bone is placed into the defect and no dissection is carried into the premaxillary vomerine suture. However it almost always leads to adverse developmental effects on postnatal maxillary growth leading to complications like retruded maxilla, cross bites, and poor

Fig. 10 A 10-year old patient with a unilateral cleft between the left central incisor and canine

Fig. 11 Radiographs taken before, 6 months after and 1 year after grafting with evident bone fill at the cleft site and the lateral incisor erupting through the bone graft

Fig. 12 Unilateral alveolar cleft and palatal fistula between the left central incisor and canine in a 14 year patient who was given a reverse pull headgear to limit forward growth of mandible

alveolar morphology with unerupted or unsupported teeth [14].

Sagittal and transverse growth of the anterior maxilla continues till the age of 7–8 years. Studies have shown that patients who underwent mid and late secondary osteoplasty procedure had more favourable nasomaxillary profile than those who had undergone early secondary osteoplasty procedure, who invariably had flatter facial profiles [3, 13, 14].

Fig. 13 Complete closure of alveolar cleft defect in the 14-year old boy at 1 month postoperatively

Boyne and coworkers confirmed that bone grafting of the alveolar cleft defect during the mixed dentition stage was safe, predictable, and preferable [22, 23, 24]. Sagittal and transverse growth of the anterior maxilla virtually ceases by the age of 8–9 years [25]. The vertical growth of the maxilla occurs mainly as a result of deposition of additional alveolar bone at the alveolar crest. Continuous eruption of teeth stimulates formation of alveolar bone. Viable graft at the alveolar cleft site is rapidly transformed into functional alveolar bone responding physiologically to erupting teeth by orthodontically guided eruption of the canine. Thus the capacity of erupting teeth to generate alveolar bone can be utilized to maintain growth in maxillary height.

Studies have shown that alveolar cleft grafting performed at ages 9–12 had no adverse effects on the anteroposterior or vertical maxillary growth [3, 24]. Grafting done prior to the eruption of the permanent canine and when its root is 50 % complete, as was done in the first four cases of this study, has been shown by several literature reports to be the ideal time to perform alveolar cleft grafting, as opposed to the late secondary grafting after 12 years of age, or to the primary or early secondary bone grafting [3, 24]. It helps in creation of alveolar bone which

Fig. 14 Pre-treatment appearance and appearance following cleft repair and post-surgical orthodontics with a partial denture to replace the congenitally missing left lateral incisor

Fig. 15 A 14-year old patient with a bilateral cleft defect, maxillary arch was orthodontically expanded

responds normally to eruption and orthodontic movement of teeth, allows eruption of the canine into the newly formed bone and has minimal impact on facial growth [15]

also reduces the duration of orthodontic treatment by preventing significant maxillary segmental collapse. Early obliteration of oronasal fistulae at the alveolar level

Fig. 16 Bilateral alveolar cleft defect prior to and after 1st stage alveolar cleft repair showing the graft material at the base of pyriform rim and mesial to the apical third of the canines

Fig. 17 Bone fill evident at the base of the bilateral alveolar cleft after the first stage grafting. There has also been orthodontic widening of the arch prior to grafting

Fig. 18 A 13-year old patient with a bilateral alveolar cleft defect

Fig. 19 Alveolar cleft sites exposed and grafted using iliac crest corticocancellous bone graft

Fig. 20 Pre- and 6 month's post- op radiographs showing good bone fill at the grafted sites

Fig. 21 A 14-year old patient with a unilateral alveolar cleft between 21 and 23 with missing 22

Fig. 22 Cleft site exposed and grafted using iliac crest corticocancellous bone graft

Fig. 23 Radiographs taken prior to grafting and 6 months following grafting showing good bone fill at the cleft site

Fig. 24 Late secondary alveolar cleft grafting in a 16-year old patient

Fig. 25 Pre-op and post-op photographs showing a complete closure of the alveolar cleft defect

Fig. 26 Satisfactory closure of the palatal fistula achieved

Fig. 27 A good bone fill evident at the grafted cleft site at the end of 6 months

promotes improved oral and dental hygiene and speech development [5]. Bone grafting between ages 9 and 12 years have no adverse effects on anteroposterior or vertical maxillary growth according to cephalometric studies [16, 17]. On the other hand, according to literature reports [3, 18–21], the drawbacks of delaying alveolar cleft grafting to the permanent dentition stage, could result in malposition or impaction of the erupting canine thus prolonging the duration of post-operative orthodontics [18–20] also, late grafting is associated with less graft uptake, more remodeling and eventually, less alveolar height [3, 21].

In the present study, comparable results were obtained in both groups following alveolar cleft repair.

Conclusion

Recognizing the fact that patients with cleft lip and palate undergo multiple surgeries prior to adulthood, choice and timing of surgical procedures becomes very important. In our study both mid-secondary as well as delayed-secondary alveolar cleft repair produced comparable results. Although the results do suggest that precise timing for secondary alveolar cleft repair may not be all that crucial, larger and long term studies are required to establish the inferences.

Conflict of interest None.

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