Alternative donor site for alveolar bone grafting in adults with cleft lip and palate

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Cleft lip, with or without palate involvement, is a common congenital deformity. Although it is not fatal unless associated with other serious congenital diseases, it is an important public health problem worldwide because it carries a great deal of social, functional, and psychological morbidity.[1-3]

Clefts of the lip are usually repaired during the first 3 to 6 months after birth, and clefts of the palate are often repaired at 1 to 2 years of age. Early closure of the lip results in establishment of continuity of the perioral musculature, which has both esthetic and functional benefits. Continuity of a functioning soft palate is an important prerequisite for the development of speech. Repair of the palate may be a one-[4] or two-stage[5] procedure and may be performed with or without the provision of an obturator. Continuity of the soft tissues is obtained, but bony defects in the alveolus and hard palate remain. Indications for alveolar bone grafting include closure of persistent oronasal fistulae, bone support for unerupted and erupted teeth adjacent to the cleft, stabilization of the premaxillary segment in bilateral cases, continuity of the alveolar ridge, and support of the alar base and nasolabial contour.

Primary bone grafting in conjunction with primary cleft repair was popular during the 1950s,[6] but long-term evaluation of results indicates that this technique interferes with the normal growth and development of the maxilla.[7,8] Contemporary repair of the residual alveolar and hard palate clefts supports the concept of secondary bone grafting described by Boyne and Sands.[9] The best

Abstract

Grafting of the alveolar ridge with autogenous bone is an integral stage of contemporary management of complete cleft lip and palate cases. Alveolar bone grafting restores continuity of the dental arch, closes oronasal fistulae, supports the alar base, and facilitates spontaneous eruption of permanent teeth adjacent to the cleft. However, timing of the graft and the selection of materials have been topics of much debate in the literature.

This article discusses an alternative donor site in cases where rehabilitation has passed the recommended time. Harvesting bone from the third molar regions allows not only the removal of impacted third molars during the same surgical procedure, but also eliminates the morbidity associated with additional surgical sites such as the ilium or mandibular symphysis. This report should not be interpreted as a recommendation for the use of this alternative site in cases where grafting is carried out within the optimal time period, which is usually in the mixed dentition stage. However, when grafting is necessary in young adults suffering from complete cleft lip and palate, the third molar region may provide another acceptable donor site.

Key Words

Cleft palate • Alveolar bone graft • Adults

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time for bone grafting is during the mixed dentition.[10,11] One of the primary aims is to eliminate the need for prosthetic replacement of missing teeth, either by allowing the adjacent teeth to spontaneously erupt through the autogenous graft or to take their place via orthodontic tooth movement.[12-14] Although teeth adjacent to nongrafted alveolar clefts show signs of gingivitis but not of periodontal disease,[15] the discontinous dental arch presents problems for the orthodontist. Easier orthodontic closure of the cleft space and more favorable height of interdental bone septum result where bone has been grafted prior to eruption of the permanent canine.[16]

Preferred donor sites for the autogenous bone include the ilium,[13,17,18] mandibular symphysis,[19] rib,[20] and cranial vault.[21] Such grafts offer clinical advantages because the entire cleft can be filled with viable bone. Teeth that erupt through grafted bone respond well to orthodontic or orthopedic forces and to maxillary growth.[12] Success of the autogenous graft depends on revascularization through microanastomoses. Such revascularization is particularly rapid in cancellous bone due to its trabecular surfaces and existing openings.[22-24] Although cortical grafts give initial form and strength for reconstruction, revascularization is lengthy due to the more compact structure with fewer surface openings; this results in a slow transformation and a weaker implant.[23-25]

The greatest disadvantage in using autogenous tissue is the necessity of a second surgical site for harvesting the donor bone. This harvesting procedure carries some morbidity. An average of 355 ml of blood is lost following iliac crest and alveolar grafting procedures.[26] Delayed ambulation ranges from 8 to 10 days.[27] Other complications include pain, wound dehiscence, hematoma, seroma, paraesthesia, potential disturbance of ilium development in young children[17,28] and potential risk to apices of anterior teeth in harvesting mandibular symphyseal bone. In addition, the amount of bone harvested is somewhat limited. Because the preferred age for repair of maxillary alveolar clefts is between 9 and 11 years, such morbidity need not be accepted as inherent to the repair procedure. Technical and theoretical innovations are being sought to reduce morbidity and yet retain the excellent functional and esthetic results. Harvesting of donor bone from either the rib or the cranial vault is not readily acceptable among people of some ethnic groups, especially the Chinese, because of cultural beliefs. Moreover, cranial bone has already been reported to be unsatisfactory, as ingrowth of fibrous tissue and periodontal defects can form around the adjacent teeth in the grafted area.[29]

The use of allogenic bone in the maxillary alveolar clefts may reduce morbidity by rendering the harvesting of autogenous bone unnecessary. The concept of allogenic bone as a graft material in bony clefts of the palate as well as in the maxillary alveolus is not new; it was used extensively in the 1950s.[30] With the establishment of allogenic bone banks, bone became available as frozen or freeze-dried (lyophilized) cortical and cancellous explants that have undergone rigorous and costly screening procedures to decrease the risk of disease transmission[31] and to reduce the humoral immunogenicity and host rejection. However, such bank bone still has associated biological and clinical disadvantages, because its antigenic constituents will evoke a localized cellular immunodefensive reaction[32] and subsequently retard revascularization and osteoinduction.[33] Clinically, these biological processes manifest as delayed acceptance and increased risk of dehiscence and sequestration. In addition to these problems, the availability of bank bone in some communities has always been very limited, because donations are generally nontraditional—even unacceptable—among some ethnic groups. Thus, grafting maxillary cleft alveolus with bank bone has a rather low priority in such populations.

Bioceramic hydroxyapatite has greater compressive and transverse strength than enamel.[34] It shows no evidence of adverse inflammatory or cytotoxic local or systemic foreign-body response when used as a biological implant material for procedures such as alveolar ridge augmentation.[35,36] These materials display excellent histocompatibility and some osteoconduction,[37] and they do not possess any osteoinductive activity.[38] Although hydroxylapatite has been used successfully in the repair of artificial residual alveolar clefts in animals, the long-term effects on the growing maxilla and eruption of teeth in humans are unknown.[39,40] Thus, hydroxylapatite is not used to repair maxillary alveolar clefts, especially in young children between 9 and 11.

The search for an autogenous bone substitute began a century ago when HCL-demineralized bone chips from ox tibiae were implanted into canine cranial defects. Although the healing was incomplete, bony ingrowth was observed at the margins of the defects. It was concluded that the decalcification process had provided a more antiseptic environment for bone growth.[41] Demineralized long bone fragments stimulate osteogenesis in subcutaneous sites.[42] This finding produces an excellent experimental model for scientific evaluation of the mechanisms of bone formation. The cellular events of osteoinduction involve transformation of undifferentiated mesenchymal cells to chondroblasts and osteoblasts.[43] Factors responsible for osteoinduction are apparently homologous in human, monkey, bovine and rat matrices.[44] Bone morphogenetic protein (BMP) is isolated from bone matrix as a bioactive factor which may contribute to the process of osteogenesis.[45] Completely decalcified ultrafine particles of allogeneic bone enhance BMP activity.[46] Undecalcified freeze-dried allogeneic bone induces bone formation within maxillary clefts of dogs, but the shortcomings included an insufficient amount of bone formation and the prolonged time required for bone formation.[47]

The work of Urist[42] and others on bone induction supports the concept that BMP, an acid-insoluble protein in the organic portion of bone mineral matrix, affects the genetic machinery of mesenchymal cells. Mesenchymal cells, such as those in the cancellous bone and marrow or fibroblasts within a graft recipient bed, are induced to form bone as functional osteoblasts. Cortical bone contains the highest yield of BMP per gram.[48] Bovine BMP has been demonstrated to augment implants like porous hydroxylapatite and collangenous delivery systems with more rapid bony ingrowth, increased strength and stability.[49,50]

An ideal alternative to autogenous bone grafting may incorporate the advantage of osteoinduction without the disadvantages of such limited availability and a second surgical procedure required for autograft procurement. Protein extracts from various types of bone can provide an implant which is osteoinductive and available in virtually unlimited supply. An osteoinductive material that is available without costly preparation and in unlimited supply will represent a major advance in applied bone biology, as it can speed up bone regeneration and eliminate the associated risks in harvesting autogenous grafting materials. Although BMP seems to be a promising material of choice, it is lost during delayed collection time, irradiation, heating, cryolysis, and from exposure to chemicals such as hydrogen peroxide.[51] Much research and development are necessary before this can substitute for the commonly used autogenous bone.

Third molars are impacted in around 20% of individuals.[52] Impacted third molars are generally removed for prophylactic or orthodontic reasons. Other indications include pericoronitis, caries, pulpitis, and other rare pathological entities, such as cysts, tumors, and root resorption.[53,54] Impacted molars can result in symptoms such as pain, trismus, or swelling, especially in those molars partially covered by soft tissue.[53] Controversy exists in removal of impacted third molars as some clinicians believe these teeth may be left in place, especially when the cure may be worse than the disease.[54] Actually, rates of complications and side effects associated with surgical removal of impacted third molars are low,[55-57] especially in younger people who have favorably positioned impacted third molars.[56] Postoperative morbidity after third molar surgery increases with age and unfavorable consequences occur more frequently.[58,59] Removal of mandibular third molars is better and easier to perform in young adults.[60-62] Early removal of third molars is found to have reduced postoperative morbidity, better healing, quicker recovery, and better periodontal reattachment.[58,60] Therefore, it is generally agreed that impacted teeth should be considered for removal as soon as the diagnosis can be reached,[60] i.e., when it first becomes apparent that the third molars do not have enough room for occlusion.[63] The ideal time for removal of impacted third molars, according to some authors, is as early as the late teenage years, between 16 and 18 years, when the roots are more than one-third but less than two-thirds formed.[60] Normally, removal of impacted third molars is recommended for individuals under 30 who are in good health without other possible complicating physiologic or pathologic conditions.[64]

Case presentation

A 15-year-old Chinese girl born with complete unilateral cleft lip and palate was referred to the orthodontist because she had an anterior crossbite. Primary repairs of the lip and palate had been performed at the age of 3 months and 16 months, respectively, and although the patient had received some routine dental treatment, she had not received proper follow-up for the cleft lip and palate repairs. Her medical history was otherwise noncontributary.

She presented with a mixed dentition where 65, 75, and 85 were retained. The malocclusion was Class III with anterior crossbite, persistent alveolar cleft, missing 22 and grossly carious 21. Lip contour and nose symmetry was less than accept-

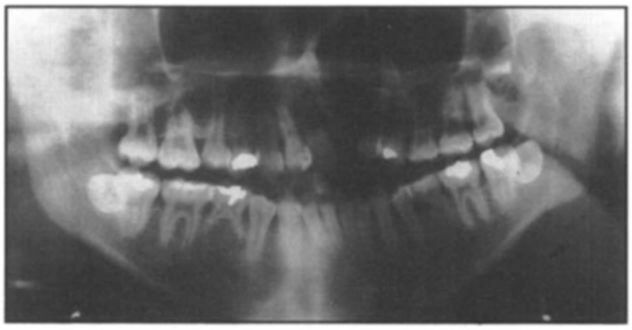

Figure 1A

Figure 1B

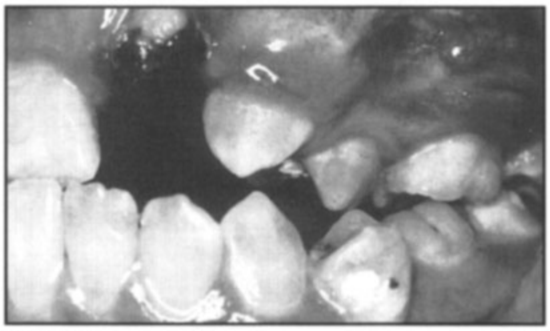

Figure 1C

Figure 2

Figure 1A-C
Pretreatment records.
A: Panoramic radiograph shows missing 22, 25, 35, and 45; severe resorption of the mesial root of 75; and unerupted developing third molars.
B: Upper anterior occlusal radiograph shows the persistent alveolar cleft and normal status of the root of the grossly carious 21.
C: Intraoral photo shows the inclination of teeth adjacent to the cleft.

Figure 2
Periapical radiograph shows the bone level adjacent to 21 and 23 during orthodontic treatment.

able. Radiographs revealed congenital absence of 25, 35, and 45 with severe resorption of the mesial root of 75; normal status of the root of 21; and unerupted developing third molars (Figure1A-C). Analysis of the lateral cephalometric radiograph showed a skeletal Class I pattern with an ANB angle of 2°.

The initial treatment plan included the following phases:

1. Revise the lip and nose and graft alveolar bone to repair the persistent cleft so that adjacent teeth could be uprighted;
2. Extract the retained 65, 75, 85, and 14, with subsequent orthodontic space closure to correct the anterior crossbite and crowding and to align the arches. Due to the agenesis of both 22 and 25, regaining space for a prosthetic 22 would seem appropriate;
3. Restore 21 and replace 22 with a prosthesis following the orthodontic treatment;
4. Review the developing third molars and consider removal when impaction occurs.

The plan was then presented to the patient and her mother. They rejected phase 1 treatment because they did not believe the proposed lip and nose revisions were necessary. In addition, they decided the alveolar bone grafting was unacceptable because it would involve harvesting bone from other parts of the body, such as the ilium or mandibular symphysis. Therefore the orthodontic phase of treatment was carried out with the presence of a persistent alveolar cleft. During the 12 months of fixed orthodontic treatment, extreme care was exercised to avoid any deleterious effect in moving 21 and 23 (Figure 2). By the end of phase 2 (Figure 3), they were happy except for the poor appearance of the temporary restoration of 21. After 4 months of full-time retention, a prosthetic replacement for 22 was fabricated; the retainer on 21 was a ceramo-metal crown, while that on 23 was retained with adhesive.

Figure 3

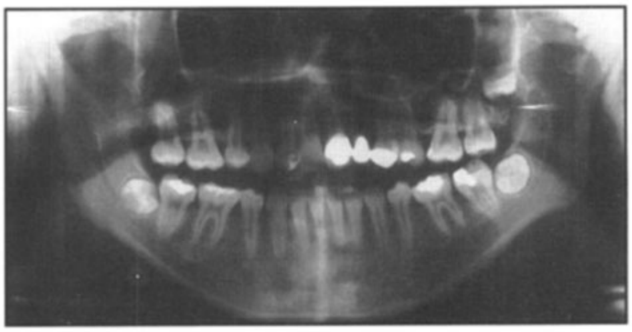

Figure 4A

Figure 4B

Figure 4C

Figure 3
At the completion of orthodontic treatment, a temporary restoration was used for 21.

Figure 4A-C
Follow-up records were collected 2 years after orthodontic treatment.
A: Panoramic radiograph shows impaction of 38 and 48, very initial development of 18, and high anatomic position of 28.
B: Periapical radiograph shows bone level adjacent to the persistent alveolar cleft.
C: Note the persistent alveolar cleft beneath pontic 22.

Two years later the patient returned, requesting improvement of her lip and nose appearance. The orthodontic and prosthodontic results appeared to be stable (Figure 4A-4C). After consultation with the plastic and oral surgeons, grafting the alveolar cleft was decided because it would contribute to support of the alar base. Bone would be harvested during the removal of the impacted mandibular third molars. Lip and nose revisions were to be performed under the same general anaesthetic procedure. Because the maxillary third molars were still high in their anatomic positions, indicating potential intraoperative as well as postoperative complications, they would be left alone. During the operation, bone covering the mandibular third molars was removed with a mallet and chisel while the teeth were elevated. The harvested bone was cut into smaller pieces and then grafted to the cleft alveolus with the bridge replacing 22 left in situ. Overfill of the recipient site with the donor bone chips was not possible in this case. Revisions of the lip and nose were then performed. Two grams of Velosef and 1.5 grams of Flagyl were given intravenously in divided doses for the first two postoperative days. For the following three days, 1 gram of Velosef and 1.2 grams of Flagyl were given orally. All operated sites healed uneventfully.

The results were satisfactory after 1 year despite the fact that the grafting was performed much later than the optimal time. The bridge remained esthetically and functionally acceptable with healthy periodontal tissues (Figure 5A-C).

This case demonstrated an alternative treatment plan for young adults who have nongrafted alveolar clefts and impacted third molars. This procedure is advantageous because it eliminates the morbidity associated with an additional surgical site for harvesting donor bone. It also combines removal of impacted third molars and revisions of the lip and nose under the same surgical procedure.

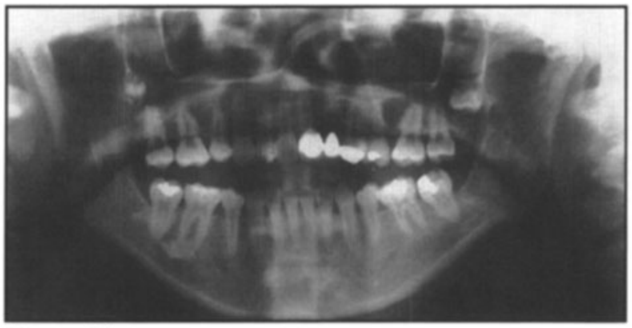

Figure 5A

Figure 5B

Figure 5C

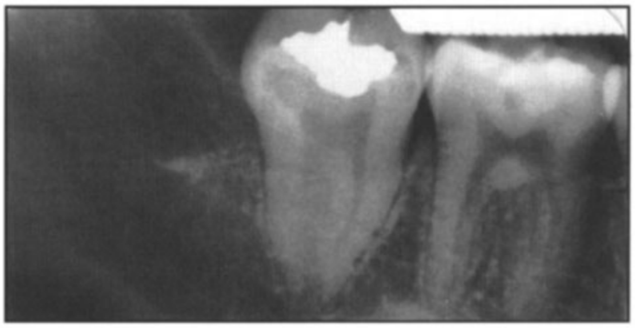

Figure 5D

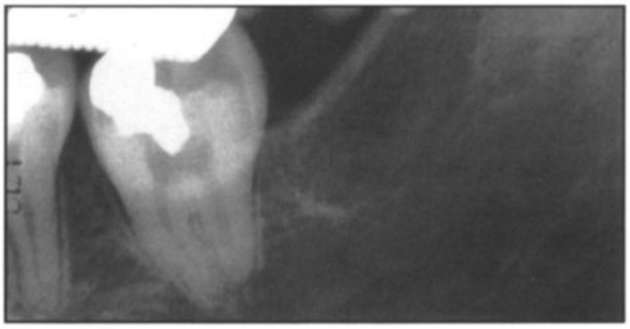

Figure 5E

Figure 5
Records were collected again 1 year after the simultaneous alveolar grafting, removal of 38 and 48, and lip and nose revisions
A: The panoramic radiograph shows 18 and 28 left as they were, very high in the maxilla.
B: Intraoral photograph shows that the cleft has been eliminated but that minimal gingival recession has occurred around the restorations of 21 & 22.
C-E: Periapical radiographs show the bone contour at the grafted alveolus and uneventful healing of sockets associated with 38 and 48.

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