CASE REPORT

Reconstruction of an alveolar cleft for orthodontic tooth movement

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Bone grafting to repair an alveolar cleft has long been an integral part of the treatment of persons with unilateral and bilateral clefts of the lip and alveolus. The presence of the cleft places a limitation on the orthodontist who would like to move teeth in the area of the cleft. Various grafting materials have been placed in alveolar clefts in an attempt to solve this problem. The case to be presented is a patient with a Class II, Division 2, malocclusion with a left unilateral alveolar cleft and a repaired cleft lip. Ten months after initiating orthodontic treatment, a free gingival graft procedure was performed because of insufficient vestibular depth and the narrow width of the keratinized attached gingiva at the left maxillary lateral and central incisor region. Two months after periodontal surgery, a mix of decalcified freeze-dried bone allograft and a granular bioactive glass graft material (1:1) were applied subperiostally on the buccal aspect of the edentulous cleft region. Six months later, the teeth adjacent to the grafted alveolar cleft were orthodontically moved into the edentulous area. The treatment results indicated that orthodontic, periodontal, and surgical interventions resulted in a successful closure of the alveolar cleft as well as improved periodontal conditions of the teeth adjacent to the cleft area. From the orthodontic point of view, tooth movement can be achieved successfully into a bone graft made of freeze-dried bone and bioactive glass. (Am J Orthod Dentofacial Orthop 2000;117:156-63)

Cleft lip and palate are congenital craniofacial malformations with an incidence of approximately 0.36 to 0.83 per 1000 live births.[1] Treatment of the residual alveolar defect in patients with cleft lip and palate often requires bone grafting.[2] An important goal for this treatment, apart from restoring the missing alveolar bone in the cleft area, is to obtain favorable periodontal conditions for the teeth adjacent to the defect. Attempts to move the teeth into the edentulous spaces often result in significant periodontal problems.

Early or primary bone grafting of the cleft maxilla and palate as part of the treatment regimen during cleft palate rehabilitation is still controversial. Although the first reports of primary bone grafting were published in 1908,[3] the procedure was re-introduced in the 1950s. Subsequent long-term studies of patients who underwent this treatment in the first few years after birth reported less favorable maxillary growth. As a result, interest in this treatment modality progressively declined.[4-6]

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Timing of bone grafting is generally described as "primary,"[7] "secondary,"[8] and "delayed."[9] Nowadays, primary bone grafting in the early ages is not popular because of the adverse effect on growth of the maxilla.[10] However, secondary bone grafting techniques delay the placement of the graft until growth is completed.[8,11] Several centers have adopted this procedure and have reported favorable results.

The canines are expected to migrate and erupt through the grafted area,[8,9] an improved bony environment that facilitates orthodontic and prosthodontic treatment and improved stability and health of the periodontium.[12-14] Recently, delayed grafting has been reported as a possible approach to achieve a firm anatomic base to aid orthodontic and prosthodontic management[15-17] while avoiding interference with facial growth.[18] Opponents of delayed grafting believe that postponement of grafting jeopardizes the teeth adjacent to the cleft[8,19] because of lack of sufficient bone support.

From an orthodontic point of view, the problem has been with the deficiency of the buccolingual alveolar width into which teeth can be moved. As a result, autogenous cancellous bone is placed subperiostally on the buccal aspect of the constricted edentulous space, and the adjacent teeth are then orthodontically moved into the grafted edentulous area.[20]

Several studies demonstrate that freeze-dried bone allograft serves as a successful osseous grafting mater-

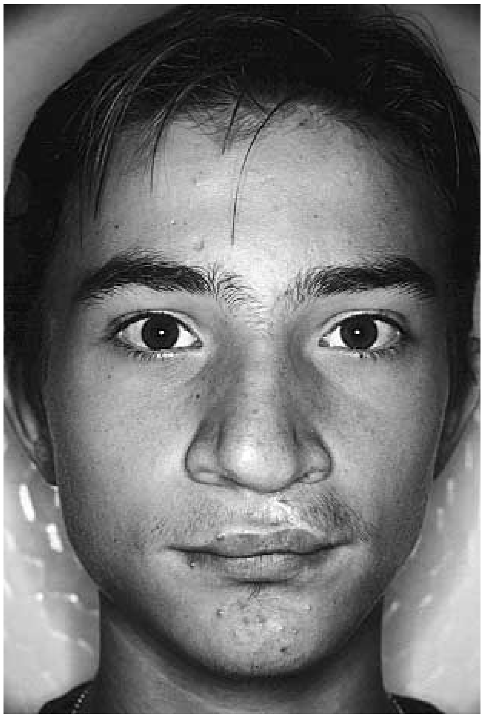

Fig 1. Extraoral pretreatment frontal view.

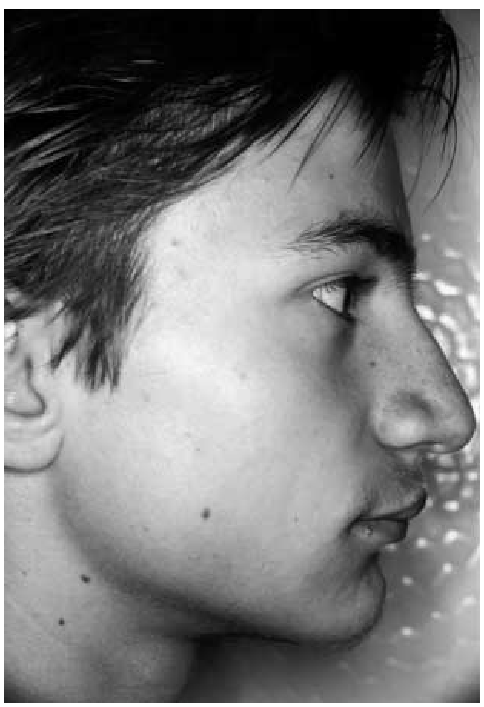

Fig 2. Extraoral pretreatment profile view.

Fig 3. Intraoral pretreatment right site view.

Fig 4. Intraoral pretreatment frontal view.

Fig 5. Intraoral pretreatment left (alveolar cleft) site view.

ial.[21,22] This material has been found to be a safe and convenient "on the shelf" grafting material in periodontal defects for more than a decade.[23,24] The results of a histologic evaluation of new attachment in human beings by Bowers et al[25] demonstrate the formation of a new attachment apparatus with the use of demineralized freeze-dried bone allograft (DFDBA) in periodontal defects. Urist et al[26] reported enhanced heterotopic bone formation with a composite system of beta-tricalcium phosphate used as a carrier for bone morphogenic proteins (BMP). Doll et al[27] used hydroxyapatite as a

Fig 6. Alveolar cleft site before periodontal treatment.

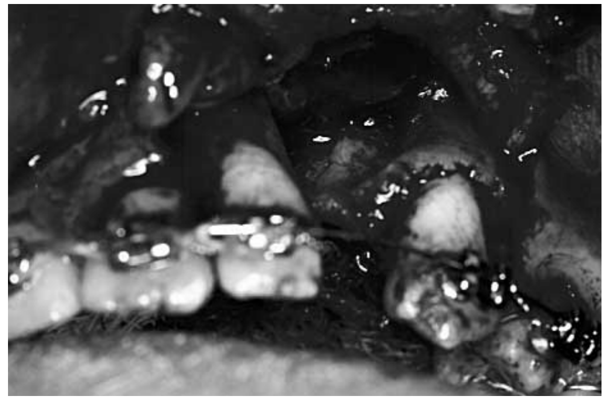

Fig 8. Alveolar cleft site during periodontal surgery.

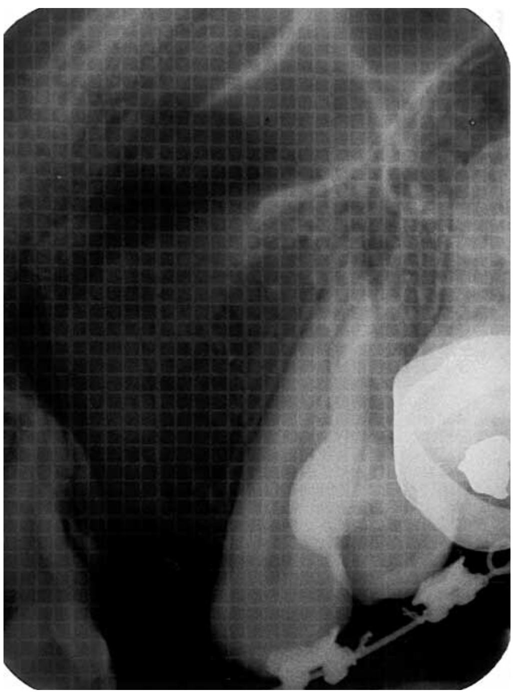

Fig 7. Periapical radiograph of alveolar cleft site before periodontal treatment.

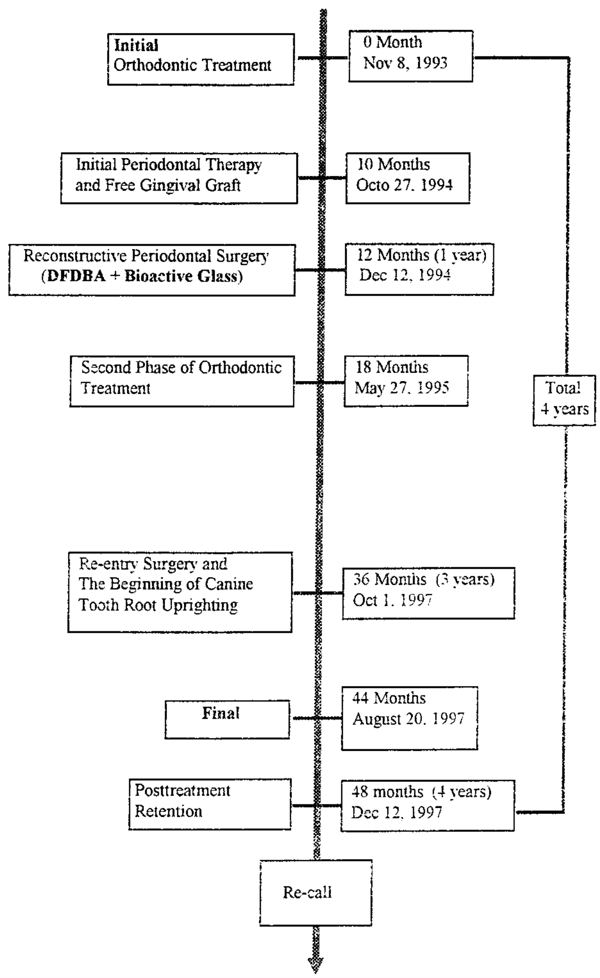

Fig 9. Orthodontic and periodontal treatment plan.

carrier for BMP in critical-sized craniotomy defects and reported positive results.

The material known as bioglass has been developed over a 28-year period to have specific surface activities that would ensure bonding with living tissue.[28,29] Bioactive glass is a silicate-based synthetic bone augmentation material that has been used to fill periodontal defects with bonding and integration to both soft tissue and bone. Some studies demonstrate the successful use of 45S5 particulate form bioactive glass (PerioGlas) graft material in periodontal defects.[30,31] This material has also been shown to be effective in maintaining the alveolar ridge after extraction,[32,33] and it has been used in peri-implant intrabony defects.[34]

The principles followed in treating the present case are based on the findings from these investigations.

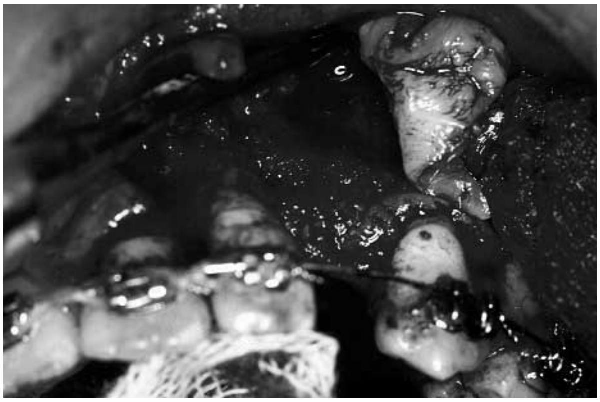

Fig 10. Alveolar cleft defect site filled with DFDBA + bioactive glass.

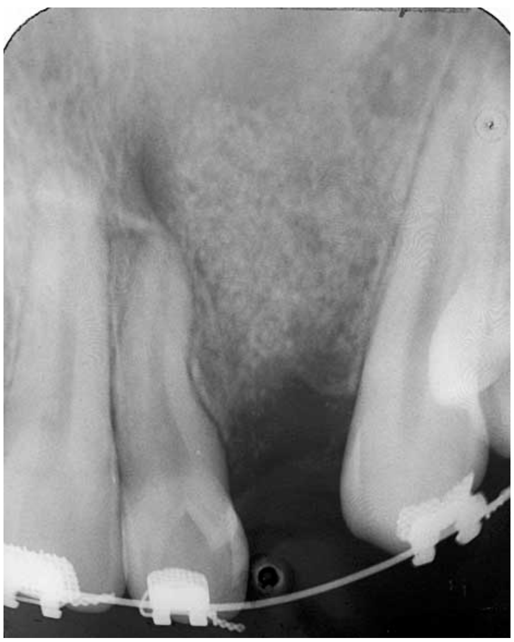

Fig 11. Immediately postoperative periapical radiograph of alveolar cleft site.

Fig 12. Alveolar cleft site as revealed by re-entry surgery 2 years after reconstructive periodontal surgery.

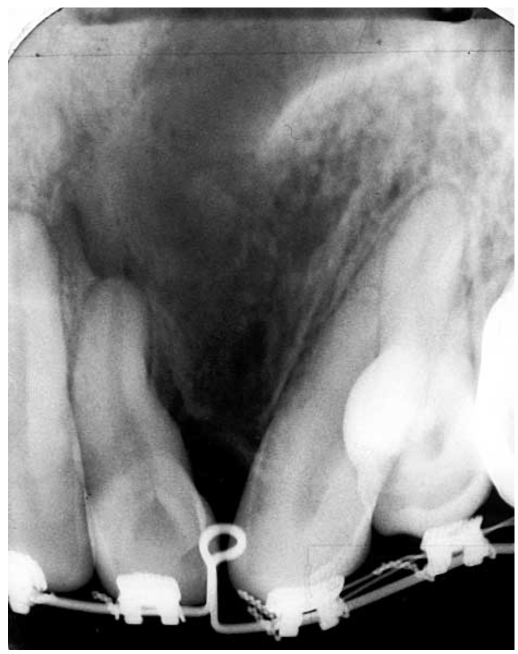

Fig 13. Periapical radiograph of alveolar cleft site 2 years postsurgery.

The goals of the treatment of the patient were: (1) to achieve optimal gingival and periodontal health, (2) to reconstruct the cleft site and alveolar ridge to allow for tooth movement, (3) to correct the Class II, Division 2 malocclusion, (4) to examine the long-term clinical success in the grafted cleft region, (5) to achieve a functionally stable occlusion, and (6) to achieve improved facial and dental aesthetics.

CASE HISTORY

The patient was referred to our clinic at the age of 16 years. He was born with a unilateral left cleft lip and palate. The cleft lip was surgically repaired at an early age. The history indicated that there was no known familial incidence of clefting. At the time of the initial orthodontic evaluation, the patient was in the permanent dentition stage with a Class II, Division 2 malocclusion left subdivision. There were no missing teeth at the site of the cleft. There was 5 mm maxillary and 2.5 mm mandibular space deficiency for the alignment of the dentition. Maxillary midline was shifted 2 mm to the left. The maxillary left second premolar was palatally positioned. The initial extraoral and intraoral pictures periapical radiograph of the cleft site, and the progress of treatment are presented in Figs 1-8. Radiographically, an alveolar cleft

Fig 14. Beginning of canine root uprighting.

Fig 15. After the canine root uprighting (44th month).

was seen between the maxillary left canine and lateral incisor (Fig 7). Clinically, there was no apparent fistula at the cleft site. Because of the surgical closure of the lip at an early age, there was a deficient vestibular alveolar sulcular depth. A high anterior frenum attachment was also present.

ORTHODONTIC AND PERIODONTAL TREATMENT PLANS

The chronology of orthodontic and periodontal treatment is described in Fig 9. The orthodontic treatment plan required extraction of the palatally positioned maxillary left second premolar. After orthodontic alignment of the maxillary dentition, the size of the cleft was increased (Fig 6), and there was no alveolar bone crest apparent. Before periodontal surgery, the patient had received oral hygiene instruction, as well as scaling and root planing. In order to establish sufficient keratinized attached gingiva, an initial free palatal soft tissue autograft operation was carried out. Two months later, reconstructive periodontal surgery was performed with a sulcular incision and mucoperiosteal flap reflection at the alveolar cleft site. Soft tissue within the cleft was removed (Fig 8). Extra attention was paid to avoid any injury to the root structure and the surrounding bone covering the roots. The alveolar cleft region was filled with a 1:1 mixture ratio of demineralized freeze-dried cortical bone allograft (DFDBA), (University of Florida Tissue Bank, Alahua, Fla) and a granular form of bioactive glass (BG) alloplastic graft material (PerioGlas; US Biomaterials Corp, Alahua, Fla) (Fig 10).[27,28] The flap was sutured and a postsurgical periapical radiograph was taken (Fig 11). Sutures were removed after 10 days**.** Amoxicillin 500 mg 3 times a day was prescribed for 10 days, and the patient was instructed to rinse twice daily with 0.2% chlorhexidine digluconate (Chlorhexamed 0.2%, Blend-a-med

Fig 16. Radiography 32 months after surgery.

Forschung-Blendax, Mainz, Germany) for 6 weeks. The patient was seen once a month for 6 months. In the second phase of fixed orthodontic treatment, ideal overbite, overjet, and occlusal relationship were established. At the end of the second phase orthodontic treatment (2 years after the grafting procedure), re-entry was performed to observe whether there was sufficient bone width for canine root uprighting (Figs 12 and 13). With the help of uprighting spring and Z bends on a continuous arch wire, the root tip of the canine was brought into the cleft site (Figs 14 and 15). The root movement into the graft area lasted 8 months, and the radiographic changes were recorded 32 months after reconstructive surgery (Fig 16).

Fig 17. Extraoral posttreatment frontal view.

Fig 18. Extraoral posttreatment profile view.

Fig 19. Intraoral posttreatment right site view.

Fig 20. Intraoral posttreatment frontal view.

Fig 21. Intraoral posttreatment left (alveolar cleft) site view.

EVALUATION OF TREATMENT

Overall, the periodontal and orthodontic results closely correlated with the periodontal and orthodontic treatment objectives. No postoperative infection or sequestration occurred. Gingival recession was not observed postoperatively. Clinically and radiographically, the alveolar cleft site was successfully reconstructed with the DFDBA+BG graft materials (Figs 15 and 16). At re-entry it was noted that the entire cleft site was filled with the newly formed bone. This development encouraged us to move the root of the canine into the grafted cleft site in order to establish ideal canine inclination. At the end of treatment, optimal

Table I. Cephalometric summary

	Normal	*Pretreatment*	*Posttreatment*
SNA	82°	86°	80°
SNB	80°	77°	76°
ANB	2°	9°	4°
Witts	–1 mm	6 mm	5 mm
SN-GoGn Pln	32°	27°	29°
SN-Palatal Pln	5°-7°	12°	12°
SN-Occ Pln	14°	20°	26°
IMPA	90°	94°	104°
LI-NB	25°	17°	28°
LI-NB (mm)	4 mm	2 mm	4 mm
UI-NA	22°	17°	19°
UI-NA (mm)	4 mm	–11 mm	2 mm
Interincisor angle	131°	170°	128°
ANS-Me/N-Me	55%	52%	54%

occlusion, overbite, overjet, interincisor angulation, and Class I canine relationship and inclination were established with good facial and dental esthetics. Tooth movement was achieved successfully into the DFDBA and BG grafted cleft region (Figs 15 and 17). These results indicate that these materials did not prevent the movement of the tooth into the grafted area. Radiographically, no resorption was observed on the canine root (Fig 16). The final extraoral and intraoral pictures are presented at Figs 17-21. Pretreatment and posttreatment superimpositions and cephalometric summary are presented in Fig 22 and Table I. Total active treatment time was 44 months.

DISCUSSION

According to the literature, autogenic grafts are mostly used, however, alloplastic graft material has not been used to repair alveolar clefts in human beings. Alloplastic grafts have been used successfully in the repair of artificial alveolar clefts in animals.[35] However, no data can be found in the literature concerning tooth movement into an alloplastic grafted cleft site.

This case report shows that the application of mixture of DFDBA and nonresorbable graft material (bioactive glass) for alveolar cleft augmentation was achieved, and successful tooth movement into the grafted cleft site was observed. Orthodontically, the results were stable and aesthetically pleasing. The left maxillary canine was orthodontically moved into the grafted cleft site successfully. A mix of demineralized freeze-dried cortical bone allograft and bioactive glass alloplastic graft material was used to repair the cleft.

Such graft materials offer clinical advantages because the entire cleft can be filled with viable bone. Success of the autogenous graft depends on revascularization through microanastomoses.[36] However, the disadvantages of using autogenous tissue is the necessity of a second surgical site for harvesting the donor bone and also potential disturbance of ilium development in young children.[37] The concept of allogenic bone as a graft material in alveolar clefts is not new. Clinicians prefer resorbable implant materials that replace the host's bone. DFDBA eliminates the aforementioned disadvantages of autogenous bone. An ideal implant material would be the one that resorbs at the same rate of new bone formation. If an implant resorbs too rapidly, it permits shrinkage or contraction of the augmentation site before the new bone formation. On the other hand, if an implant resorbs too slowly, it may delay the new bone formation.[38]

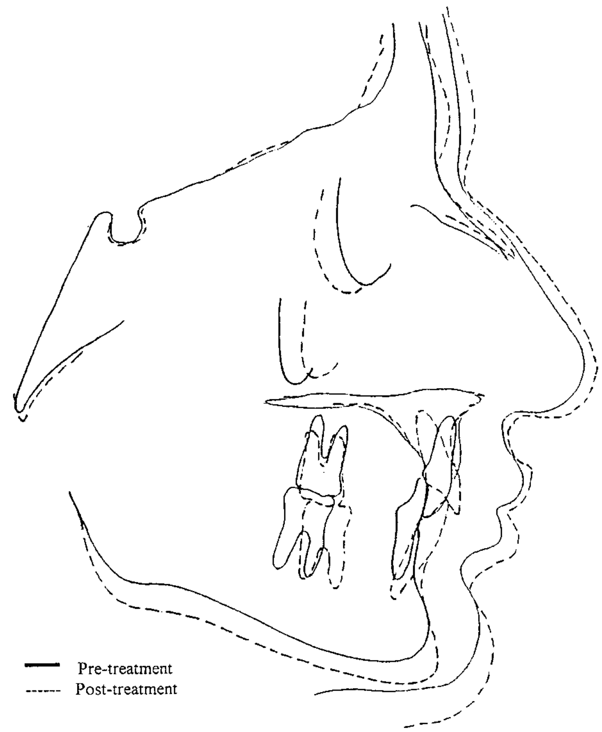

Fig 22. Pretreatment and posttreatment tracing superimpositions.

The osteogenic potential of DFDBA has been evaluated extensively in heterotopic and orthotopic sites in several animal model systems.[39,40] Human studies indicate that DFDBA is effective in the treatment of intrabony defects.[25,41]

Johnson et al[34] reported that the bioactive glass material in animals was surrounded with osteoid and new bone. It has been reported by several investigators that bioactive glass bond to soft tissue and bone better than the other available alloplastic materials.[29,42] Alloplastic graft materials that provide simply a scaffold effect to give support to vascular ingrowth and later calcification are known as osteoconductive. Osteoinductive materials, on the other hand, are those that contain morphogens, substances that initiate the development of tissues and organ systems by stimulating undifferentiated cells to convert phenotypically.[43]

These materials were mixed in order to balance the advantages and disadvantages of the materials if they were used singly. Good bone regeneration was observed after 2 years by radiographic and reentry results. The usage of allograft and alloplastic graft eliminate the morbidity associated with an additional surgical site for autogenous bone graft.

In conclusion, this case demonstrated an alternative treatment approach for augmentation of unilateral alveolar cleft patients. Orthodontic tooth movement was accomplished successfully into the grafted cleft site. In future studies, the number of the patients will be increased in order to substantiate this result.

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