Bone grafting plays an important role in the dental rehabilitation of patients with alveolar cleft. During the period between 1993 and 2001, 12 patients with alveolar clefts have been treated in our clinic. Cancellous iliac bone grafts were used in all 12 patients. Seven patients had left and five patients had right complete unilateral cleft lip and complete cleft palate operations. All patients had palatal fistulas. The ages were between 4 and 18 years (mean age, 10.5 y). Seven of them were female (58.4%) and 5 were male (41.6%). All the cancellous grafts survived. Enough filling and the closure of the fistulas were achieved except one patient who had wound dehiscence and partial graft loss. The patients experienced a limp for 2 days (mean time) because of the donor site. This surgical procedure achieves successful results if it is used with the proper indication in suitable cases.

Key Words: Alveolar cleft, repair, cancellous graft
divide nasal and oral cavities were used to facilitate nutrition by the 2nd week of life, and orthodontics were used to prevent the collapse of the maxillary arch in the preoperative period in six of the patients. Mean hospitalization time was 3 days preoperatively (range, 1–6 d) and 5 days postoperatively (range, 4–7 d). With the surgical approach, the bone defect was measured and cancellous iliac bone graft was used.

**Surgical Technique**

Under general anesthesia, local anesthetic was infiltrated (0.5% lidocaine with 1:100,000 epinephrine) approximately 1 cm below the iliac crest. An incision of 3 to 4 cm was made through skin and subcutaneous layers. Tissue dissection through the top of the crest was done carefully so as not to damage the lateral femoral cutaneous nerve. The origin of external oblique muscles and the periosteum were minimally elevated to lessen postoperative pain and limping. With the osteotomes, a cartilaginous cap was outfractured and cancellous bone was harvested with curettes. After repositioning the cap and hemostasis, the skin was sutured in layers. Local anesthetic was infiltrated to cleft margins on the oral side. The buccal side of the alveolar arch adjacent to the cleft margins was incised. Subperiosteal mucosal flaps were elevated from the first molar laterally and lateral incisor medially (Fig 3). The same manipulations were done at the lingual side. Unerupted teeth at the cleft margins were extracted in eight patients to secure the graft. First the alar base, then the lingual sides were sutured with 4/0 catgut stitches. The graft was placed into this new pocket (Figs 4, 5) and buccal side flaps were sutured with 4/0 catgut stitches.
Antibiotics were started perioperatively and used for 5 to 7 days. The patients had parenteral fluids and clear liquid nutrition for the first 2 days. Liquid and soft nutrition was given by the third day. The patients continued to use this careful nutrition for approximately 1 month. No orthodontic manipulations were done before the consolidation of the grafts. In the postoperative controls, graft loss or rejection, wound infection, flap necrosis, oronasal fistulas, and donor-side complications were investigated. Grafted area density and alveolar bone heights were controlled radiologically at the third, sixth, and twelfth months postoperatively (Figs 6, 7). Interalveolar septal height reaching 75% of the normal was accepted as successful.

**Postoperative Findings**

The average follow-up was 34 months (range, 10 mo–4 y) (Fig 8). Nine patients walked with a limp for 2 days (range, 1–4 d) resulting from the iliac bone donor site. One patient had a partial graft loss because of dehiscence in the wound during the early postoperative period. But this loss did not prevent the closure of the fistula. None of the patients had complications such as hematoma, wound infection,
or flap necrosis. All oronasal fistulas were closed successfully. No patients developed sensory disturbances or irritating scars at the donor side.

During the clinical and radiological follow-up, normal gingival contour and bony bridging in the defect margins were observed. In the patient with partial graft loss, 66% of normal alveolar height was achieved. The results of the patients are given in Table 1.

In the follow-up period in the last controls, a final density similar to that of normal maxillary regions was verified. The difference between the densities was more evident in a patient whose last control was done at the 10th months. Except for the patients who had teeth extractions, four patients had teeth eruption to the grafted area.

**DISCUSSION**

The closure of the anatomical defect in the cleft lip and palate should not prevent or impair facial growth. The most important complications encountered here are palatal fistulas and velopharyngeal insufficiency. Another point that will decrease the success of management, if missed, is the restoration of the alveolar arch.

Restoration of the alveolar arch is an important step in cleft management. There is a bony defect in the cleft side. To secure alveolar structure and prevent maxillary collapse to obtain normal facial growth, this defect should be filled with a graft. This is very important in complete clefts, because incomplete clefts don’t carry the risk of maxillary collapse. This graft supplies a suitable environment for the teeth to erupt, stabilizes the maxillary arch, closes the fistula, improves oral hygiene, gives periodontal maxillary arch, improves oral hygiene, gives periodontal support to the teeth adjacent to the cleft, forms a normal gingival contour, and with the support to the alar base, provides better nasal growth.

The most important points for grafting are timing of the surgery and the graft material. The classification for timing of the surgery is

- Primary grafting: before 2 years
- Early secondary grafting: between 2 and 5 years
- Secondary grafting: between 5 and 16 years
- Late secondary grafting: over 16 years

In the early 1900s, the first attempts at osseous reconstruction of alveolar clefts were done. Primary grafting was used in many clinics till early 1960s. The advantages of primary grafting were discussed as follows:

- Early stabilization or maxillary arch and prevention of segmental collapse
- Obliteration of oronasal fistulas to achieve better oral and dental hygiene and speech development.

Additionally, it was hoped that early repair would improve results in nutritional, aesthetic, and psychological development. On the contrary, the early studies showed that the results were not as good as expected. Robertson and Jolley and Ross reported the deteriorating effects on the maxillary arch.

Eppley stated that midfacial growth problems resulted from extensive hard palatal dissection around and across the vomerine–premaxillary suture. The author reported that the operation at an early age had advantages, such as forming no disruption in the patients’ lives (unlike school age), better maxillary arch formation, and early closure of oronasal fistulas. These would result in better oral hygiene and speech development, especially in bilateral cleft patients in whom the lack of early maxillary arch consolidation might prevent devastating secondary deformity.

Afterwards, Boyne and Sands emphasized that the primary grafting obviated the maxillary growth and suggested secondary alveolar bone grafting would obtain a complete osseous arch and superior results in facial contour. By that time it was advocated that primary grafting was disturbing the sagittal and vertical growth of the maxilla. Boyne and Sands offered grafting between 9 and 11 years, just before full eruption of the canines. Most centers prefer to perform grafting when the adjacent unerupted canine root is one-fourth to two-thirds complete. Actual studies show that the best results are obtained during the premature canine dentition period.
Boyne and Sands emphasized the advantages: improvement in the contour of the anterior maxilla in the canine–lateral incisor region, complete restoration of the osseous dental arch, improvement in facial appearance, obtaining a viable osseous structure into which the unerupted canines and lateral incisors may be moved, and closure of patent fistulas. Today secondary alveolar bone grafting is the treatment of choice.

Secondary grafting can be done with 3 kinds of materials: autogeneic, allogeneic, and alloplastic. It is generally agreed that the particulate materials are preferred to bloc corticocancellous materials because they can be incorporated faster and teeth can erupt into the graft. Iliac bone is the main donor site choice today but because of the morbidity (hematoma, infection, more blood loss, deformity, longer operation and hospitalization) new materials are being studied.

In the 1950s Blackdahl et al. studied frozen allogeneic bone in alveolar cleft management and reported superior results.

Nique et al. used particulate allogeneic bone grafts in oronasal fistulas and showed the closure of the fistula and movement of unerupted teeth to the graft. Clinical and radiological investigations indicated bony bridging but a difference in the density, and the authors emphasized that it should be used in unilateral cleft patients without unerupted teeth. They also reported that orthodontic manipulations should be done 3 months postoperatively. The disadvantages of this material are increased time for incorporation, suspicion for orthodontic teeth eruption, and its periodontal support.

It has advantages such as ease in obtaining and sterilizing, preserving its chemical and structural properties for a long time. The most important advantage is that it eliminates the need for a second operation site, eliminates morbidity, and shortens the hospitalization time.

Turvey et al. studied allogeneic particulate materials and showed that orthodontic treatment should be started in the postoperative 6th month when the normal trabecular pattern is obtained radiologically.

Marx et al. compared autogeneic and allogeneic grafts in animal studies. Both groups achieved bony bridging. But the radiographic evaluations showed 30% of the cross-sectional area of the cleft was occupied by viable bone. Nique showed that the autogeneic bone grafts stay radiolucent 3 to 6 months postoperatively during the remodeling period. But on the contrary, allogeneic grafts are still radiopaque in that period because their resorption takes more time. Actually, the most suitable material for alveolar grafting is autogeneic bone, and serious studies must be done regarding allogeneic and alloplastic materials.

Kusiak et al. showed that membranous bone grafts were revascularized earlier and grafts survived more than endochondral bone grafts. Donor bone selection should be done according to the patient’s age and volume of the defect. Donor sites are ribs, tibia, calvarium, and mandibular symphysis.

Calvarium has advantages such as no visible scar, no secondary deformity, an abundance of bone in children, less postoperative pain, briefer hospitalization, donor site in the same operative field, and greater graft survival with membranous bone. While Wolfe reported successful results, on the contrary Jackson abandoned the use of calvarial bone because of dissatisfaction with the ossification of the graft and periodontal defects along the adjacent teeth.

Mandibular symphysis has been used as a membranous bone donor site with minimal morbidity and satisfactory success rate of the grafted clefts. The main problem is that the amount that can be harvested is not always enough.

Iliac bone is the most favorable donor site actually. It provides a greater volume of graft, two surgical teams can work at the same time and so the operation time is shorter. Iliac bone grafts have more cellular tissue. Conventional open approach for harvesting iliac bone graft requires skin incision, muscle dissection, and periosteal elevation. These can result in prolonged pain (3–6 mo) and limping, infection, hematoma, irritating scar, severe pain from the pressure of clothes and belt, and local hypoesthesia or anesthesia with the injury of lateral femoral cutaneous nerve. Some authors used bone marrow biopsy needles to reduce these complications. The authors reported superior results regarding donor site infection, hematoma, sensory disturbances, and contour deformities.

Split rib graft used in primary bone grafting provides a continuous alveolar arch, but tooth eruption and healthy periodontal support is doubtful. Graft incorporation is also less sure. Pickering showed that teeth do not erupt into the rib graft.

Cullum and Horswell used alloplastic materials. The sites implanted with hydroxylapatite in animal models with surgically achieved clefts formed a generalized but variable fibroblastic response near the interface between the wall of the defect and the hydroxylapatite granules 3 months later. At 6 months, most hydroxylapatite granules

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were covered with maturing and well-collagenized fibrous tissue sheath. Partial bony bridging and some giant cells around the granules were noted. Three months after autograft bone grafting, the new bone was largely woven in nature and consisted of immature fibrous connective tissue.25

Actually materials such as hydroxylapatite are offered for use in adult patients to augment the alveolar contour but not in patients having unerupted teeth.10

SUMMARY

Bone grafting is the gold standard treatment in residual alveolar clefts. For obtaining a stable dentition and better oral hygiene, oronasal fistula should not be closed. Secondary bone grafting is preferred to avoid damage to midfacial growth. Autogeneic bone grafts are chosen because they can incorporate faster and permit eruption of the unerupted teeth. Rapid revascularization and greater graft survival make membranous bones the preferred donor sites. Iliac crest is still the most favorable donor site because it provides greater volumes of grafts, doesn’t cause severe complications, and minor problems can be reduced with careful manipulations. If alveolar bone grafting is done in suitable conditions with the right indications, the results are excellent.

REFERENCES