Converse: Chapter 48

Bone Grafting in the Cleft Palate Patient

John Marquis Converse, David M. Knize

During the last 20 years a new concept arose among surgeons performing cleft lip and palate repair: the defect represents not only a cleft but also a failure of development with a deficiency of tissue; the corollary is that the absent bony tissue should be replaced by bone grafts. It was reasoned that early replacement of the deficient bone would promote satisfactory maxillary development and maintain adequate dentoalveolar arch form.

This concept has given rise to considerable controversy between those surgeons who advocate primary bone grafting at the time of the closure of the cleft lip and those who are opposed to bone grafting for fear of impairing facial growth. Other surgeons, while opposed to early *primary* bone grafting (at the time of lip repair), favor *secondary* bone grafting (after soft tissue closure, during the period of eruption of the permanent dentition, after the eruption of the second dentition, during the adolescent years, and after the completion of facial growth).

Extensive reviews have been written on the subject (Horowitz, 1973; Koberg, 1973), including longitudinal studies presented at the Second International Congress on Cleft Palate in 1973 (Nylén and associates, 1974; Friede and Johanson, 1974).

Early Orthopedic Treatment

The popularity of the concept of early orthopedic treatment in the management of cleft palate in the English-speaking medical world was largely the result of McNeil's work (1956), in which he showed that infant orthodontics were not only possible but also effective. He developed a technique that permitted jaw function and allowed growth while controlling alignment of the maxillary segments by orthopedic means. McNeil felt that early orthodontic treatment would stimulate growth of the palatal shelves and eventually lead to their union, thereby eliminating the need for surgery. Although this degree of success was never attained, he demonstrated that the techniques could improve maxillary arch form and correct maxillary segment alignment in infants with cleft palate. Two basic types of orthodontic devices were used to treat the patient: (1) intraoral bite plate, which converted sucking and chewing movements into forces acting on the maxillary segments; and (2) external devices designed to exert pressure on a protruding premaxilla. The devices were applied a few days after birth (see also Chapter 49).

Development of Bone Grafting in Cleft Palate

The first attempts at bone grafting the cleft palates of young children were made by Lexer (1908) and Drachter (1914); Beck and Jesser (1921) used the inferior turbinate transferred on a mucoperiosteal flap to close a residual cleft. In 1931 Veau reported that he had unsuccessfully attempted to close a cleft with chips of bone from the tibia. Axhausen (1952) expressed the thinking of the time when he wrote: "If there were a means of inducing subsequent bony healing between the premaxilla and the lateral fragments, this approach

would be preferred... To find such a means, appears to me to be the final problem in the repair of complete cleft at the present time".

Schultz (1964) reported that Schmid performed the earliest bone grafting in 1944 using principles he had learned from Schuchardt. Schmid grafted costal bone at 3 and 6 months of age at the time of the cleft lip repair.

Schmid (1954), at meetings in 1951 and 1952, reported on the treatment of several patients with cleft lip and palate in whom iliac bone grafts had been placed between the maxillary segments in order to maintain alignment. Between 1954 and 1968, Schmid reported the use of bone grafts in cleft palate patients, expressing skepticism as to whether the technique would survive the judgment of time when he stated: "The procedure has merely been presented for discussion".

Nordin and Johanson (1955), after administering orthodontic treatment, transplanted bone grafts during the period of mixed dentition. Johanson and Ohlsson in 1961 reported on bone grafting in primary and secondary cases of cleft lip and palate.

Schrudde and Stellmach (1958, 1959) introduced the concept of restoring bony continuity not only in the complete bilateral cleft in order to stabilize the premaxilla but also in all alveolar clefts for the purpose of "primary alignment of the maxillary arch". In 1960 Schuchardt and Pfeifer reported successful primary bone grafting. Many other surgeons reported their use of primary bone grafting in cleft palate patients.

In 1965 Skoog described his "boneless bone graft" to repair clefts of the primary palate. He rotated a wide flap of periosteum stripped from the anterior maxillary wall, the flap being based medially along the lateral edge of the pyriform aperture. International symposia on this subject were held in Zurich (1963) and in Hamburg (1964).

The wave of enthusiasm for early bone grafting reached the United States by 1964, and the first issue of the Cleft Palate Journal included papers by Schultz (1964) and Georgiade and associates (1964) supporting early bone grafting combined with early orthodontics. Many cleft palate centers in the United States soon embraced the concept of early bone grafting, because few surgeons had been satisfied with the results using the older methods of treatment, and they were eager to try a new approach.

Early orthodontic-orthopedic realignment of the alveolar segments was also advocated preparatory to bone grafting. A plethora of reports flooded the literature (Horton and coworkers, 1964; Brauer and Cronin, 1964; Monroe and coworkers, 1968; Wood, 1970; Monroe and Rosenstein, 1971), in which the concept of early orthopedic treatment was supported. In addition, modifications of the technique were described, and hope in the new concept was expressed.

The generally expressed aims of early bone grafting, done in conjunction with orthodontic therapy in infancy, as outlined by Pickrell, Quinn, and Massengill (1968), can be summarized as follows: (1) restoration of maxillary alveolar arch length; (2) prevention of maxillary collapse; (3) stabilization of the premaxilla in cases of bilateral cleft palate; (4) lessening of tooth crowding and promotion of tooth migration into the bone-grafted area; (5)

prevention of oronasal fistulas; (6) augmentation of the palate shelf; (7) improvement of facial contour.

Disenchantment With Primary Bone Grafting

A number of skeptics began to express doubts concerning the advisability of routine bone grafting of all alveolar clefts (Ritter, 1959, 1966) and raised the possibility of inhibition of maxillary growth (Gabka, 1964). Another early dissenter was Pruzansky (1964). Based on a longitudinal study of over 1000 children with cleft lip and palate, he challenged the premises upon which early orthodontics and early bone grafting were based. He contended that there was no sound evidence to support the widespread implementation of the concepts of early orthodontic treatment of the cleft lip and palate patient, since he had found that many of the results achieved by means of orthodontic therapy developed spontaneously in the untreated patients. These views were consistent with a report of Ortiz-Monasterio and coworkers (1959), who had studied adult patients with unrepaired cleft palates.

Johanson (1966a, b), one of the early advocates of bone grafting, warned that bone grafting was justified only if maxillary growth was not impaired.

As the bone-grafted patients were followed longitudinally and their operative results appraised, doubts began to be expressed by many surgeons. Pickrell, Quinn, and Massengill (1968) followed 25 infants with unilateral cleft lip and cleft palate for four years. No growth of the bone grafts could be demonstrated, and the bone grafts failed to prevent maxillary collapse without the continued use of orthodontic appliances to maintain position. Teeth were not observed to erupt spontaneously through the bone grafts, and a satisfactory alveolar process was not reproduced since the bone graft was often absorbed, leaving an alveolar notch.

Results of Longitudinal Studies

Kling (1964, 1966) noted an 88 per cent increase in crossbite malocclusion and a 58 per cent increase in pseudoprognathism of the mandible following primary and early secondary bone grafting. Robertson and Jolleys (1968) conducted a controlled longitudinal study of patients treated with and without early bone grafting of alveolar clefts; two groups of children with palpable complete cleft lip, alveolus, and palate were studied. Each group received orthodontic treatment from birth to age 12 months, with the cleft lip and soft palate repair at 3 months and the hard palate repair at 11 months. The only difference between the groups was that one group underwent a bone grafting procedure at 15 months. By the time the children reached 10 years of age, serial cephalograms, photograms, and dental casts demonstrated poor occlusal and jaw relationships in the bone-grafted group, even though the children wore a retaining appliance for six months postoperatively. Jolleys and Robertson (1972), after analyzing their results, concluded that bone grafting impairs maxillary growth. Johanson, who in 1966 had advocated caution, stated in 1969 and 1970 that bone grafting should be condemned because of the proven poor results. In a comprehensive report in 1974 (Friede and Johanson), the same author noted the development of maxillary retrusion following primary bone grafting in unilateral and bilateral clefts and noted he had discontinued using the technique.

A group at the Karolinska Institute (Nylén and associates, 1974) continued to use primary bone grafting after a longitudinal study showed no serious maldevelopment of the facial skeleton, and the incidence of crossbite was comparatively low. The authors also felt that additional benefits of the technique were support of the alar base and facilitation of eventual closure of the palatal cleft.

In a follow-up of cleft lip and palate patients treated by orthodontics, *secondary* bone grafting (near the age of 20 years), and prosthetic rehabilitation, there was roentgenographic evidence of bony union across the cleft in 96 per cent of the patients (Johanson and coworkers, 1974). The maxilla was stabilized and relapse was prevented in practically all instances. As compared to noncleft patients, the most pronounced deviation was maxillary retrusion.

An impressive 10-year longitudinal study was reported by Rehrmann, Koberg and Koch (1970) with a series of 70 patients in whom alternate patients with alveolar clefts were bone-grafted. The bone grafts were done at 8 months of age at the time when the cleft lip and primary palate were repaired. The secondary palate was repaired at 4 years. Fifty per cent of each group required orthodontic treatment. A statistical evaluation of their results based on changes in dental occlusion observed on serial dental casts and cephalometric measurements showed a higher incidence of malocclusion in bone-grafted patients. It was concluded from the study that the bone graft interfered with normal growth after the deciduous teeth erupted, since, compared with the control group, the greatest difference from the average normal growth in the grafted cases occurred in the period between the deciduous and permanent dentition. It was proposed that a bone graft should not be done until after the permanent dentition had erupted.

Experimental Studies

There is also a considerable body of experimental evidence to support the conclusions derived from the above clinical studies. Stenström and Thilander (1967a, b) made a surgical premaxillary-maxillary suture defect in young guinea pigs. When the defect was bone-grafted, asymmetry of facial skeleton growth was observed on the side of the graft; if the defect was left open, no inhibition of facial growth was observed.

Atherton (1967) undertook a series of measurements in 15 skulls with untreated cleft palates ranging in age from infancy to late adulthood. Measurements on the noncleft side of each skull served as controlled data. He found that, as adulthood was approached, the effect of the defect on the facial skeleton contour became less apparent. Since the maxillary segment on the cleft side in the skulls was not in continuity with the nasal septum, these findings appear to contradict the theory of Scott (1956, 1959) that it is nasal septal growth which determines maxillary development.

If bone grafting in maxillary clefts does inhibit growth, the mechanism of this inhibition remains unclear. Stenström and Thilander's study (1967a, b) showed that facial skeletal asymmetry occurred even though the bone grafts placed in surgically produced premaxillary-maxillary suture defects had absorbed to a large extent and their remnants showed no union to the edges of the alveolar clefts. The grafts thus appeared to contribute little mechanical effect.

As suggested by Ross (1970), it may be that the more extensive scarring resulting from an additional surgical procedure, ie, bone grafting, acts to inhibit growth. In Ross' concept of growth of the maxilla, growth occurs primarily in the maxillary tuberosity area, with little contribution from the pterygoid plates of the sphenoid, the pyramidal process of the palatine bone, or the palatine bone proper. He stated that the only growth normally occurring on the anterior surface of the maxilla, ie, the bone graft site, is a small deposit of appositional bone; therefore, a bone graft in this area could not be expected to contribute significantly to maxillary growth. In support of the above concept of scar inhibition of bone growth or "maxillary ankylosis", Lynch and Peil (1966) showed that maxillary growth inhibition could be produced in puppies with experiment cleft palate by scar tissue formation. Kremenak, Huffman, and Olin (1970) also found that, following removal of mucoperiosteum from the palate of dogs and healing by secondary intention, maxillary growth was inhibited.

Technique of Primary Bone Grafting

Schmid (1955) used iliac bone grafts; Nordin and Johanson (1955) preferred tibial grafts in infants and iliac bone grafts in older children; Schrudde and Stellmach (1959) used costal grafts; Joss (1967) advocated bone marrow.

Schrudde and Stellmach (1949) described a technique which was ideally adapted to provide soft tissue coverage of the bone graft. After a vomer flap and a flap from the inner aspect of the upper lip were elevated, both flaps were then approximated to provide soft tissue coverage. The bone graft was placed between the flaps.

Johanson and Ohlsson (1961) performed the bone grafting procedure in a later stage, after maxillary orthopedics, in order to diminish the risk of loss of the bone due to the breakdown of the soft tissue resulting from the multiple suture lines *(early secondary bone grafting);* the technique of bone grafting varied. The bone graft was wedged between the segments, as described by Kriens (1968), a technique considered by Schrudde and Trauner (1972) to result in the formation of a solid bony bridge across the gap.

The orthodontic aspect of the wedge of bone in maintaining the position of the maxillary segments was emphasized by Lynch, Brelsford, Lewis, and Blocker (1965), who applied an onlay graft in addition to the wedged interposition bone graft.

Bone Grafting and Osteotomy to Correct Maxillary Hypoplasia

Many patients with cleft palate who have not benefited from continued orthodontic therapy have maxillary hypoplasia, pseudoprognathism, and malocclusion.

The orthodontic and surgical-orthodontic treatment of these patients is discussed in Chapters 30 and 47. Surgical treatment usually follows the orthodontic phase. Advancement of a portion of the maxilla (premolar segmental osteotomy), of the lower maxilla (Le Fort I or 1.5 advancement osteotomy), or, rarely, of the entire maxilla (Le Fort II or III advancement osteotomy) is indicated to restore adequate dental occlusion and facial form (see Chapter 30). In some patients, a midline mandibular osteotomy may be required in order to establish adequate dentoalveolar arch width and dental occlusal relationships.

The indication for one of these procedures is determined by the type of occlusal relationships in each individual case. If the molar relationships are adequate, a premolar segmental maxillary osteotomy is indicated (see Chapter 30). If the molar relationships are not adequate, an advancement of the entire maxillary arch is required. The most frequently employed osteotomy for this purpose is the Le Fort I (or 1.5) advancement osteotomy. Because of the scar tissue resulting from prior operative procedures, these advancement osteotomies are more difficult than in the noncleft patient and require the release of all constricting soft tissue.

Newer Approaches

Because a completely satisfactory method of surgical treatment of the cleft lip and palate patient is still unavailable, it is not surprising that newer approaches have evolved in recent years. These new treatment concepts must await a critical period trial. In 1965 Skoog described his "boneless bone graft" to repair clefts of the primary palate. He rotated a flap of periosteum 180 degrees from the anterior maxillary wall, the flap being based medially along the lateral edge of the pyriform aperture. Ranta and associates (1974) employed the periosteal flap technique in 36 patients with unilateral cleft lip. It was noted that patients with bony bridging across the alveolar cleft showed the same degree of cleft narrowing as those without evidence of a bony bridge by roentgenographic study. A report from the same group (Rintala and associates, 1974) showed a bony bridge in 54 per cent of patients, a diffuse bridge in 22 per cent, and no osseous formation in 24 per cent following the maxillary periosteal flap technique (Skoog, 1965). The implantation of Surgical appeared to play no role in bone formation.

Thilander and Stenström (1970) demonstrated in guinea pigs that Surgicel stimulated bone formation in experimentally created bone clefts in the premaxilla. The same authors (Thilander and Stenström, 1974) implanted Surgical in the unilateral maxillary alveolar clefts of ten patients ranging in age from 12 to 24 months; facial growth was satisfactory in all but one patient. In half of the patients, the cleft had been completely bridged by bone; in the remainder, the cleft had been considerably narrowed.

More recently, Kluzak (1972) attempted to repair alveolar clefts with osteocartilaginous rib grafts, including the epiphyseal plate. After establishing his technique in an animal model, he has begun a preliminary clinical study.

Conclusions

It appears that early bone grafting can no longer be recommended in light of the available evidence. Based on current information, a more reasonable combined surgical-orthodontic approach (Coccaro, 1969, 1974) would be to start banding deciduous teeth, which will have erupted by the age of 3 to 4 years, and to begin to correct the abnormal position of the maxillary segments of the premaxilla. Orthodontic treatment could be continued through the period of mixed dentition, if possible. Only after the secondary dentition has erupted in a permanent maxillary-mandibular occlusal relationship should bone grafting be considered. With the permanent dentition erupted, a stable dental relationship can be obtained by orthodontic therapy, and conditions are more favorable to the success of the bone graft.

At the Institute of Reconstructive Plastic Surgery, there are two indications at the present time for bone grafting: (1) stabilization of a free-floating premaxilla in bilateral clefts; this should not be attempted before the mixed dentition is present, preferably around 8 or 9 years of age; and (2) late cosmetic improvement in the area of the alveolus or alar base of the nose.