Converse: Chapter 49

Orthodontics in Cleft Lip and Palate Children

Peter J. Coccaro, Augustus J. Valauri

Many professional disciplines are involved in the rehabilitation of the patient with a cleft lip and palate. A large number of them, of necessity, render their services only periodically from birth through adulthood. The orthodontist, however, is one whose services are essential throughout the child's formative years. His knowledge of the growth and development of the jaw and dentition should be considered in planning any treatment designed to counter the adverse impact the cleft has upon the maxilla and developing dentition. The areas of interest to the orthodontist are: (1) skeletal structures (maxilla, mandible, and cranium), (2) dentoalveolar structures (teeth and alveolar processes), and (3) the relationship of the dentoalveolar structures to the skeletal structures.

Fortunately, in noncleft individuals most of the ordinary malocclusion problems involve only the dentoalveolar structures, while associated skeletal involvement, which requires treatment, occurs only in a minority of such patients. Though most of the orthodontist's work is associated with correcting dental irregularities, he can bring specialized skills to the treatment of the cleft lip and palate patient who presents a unique combination of skeletal and dental abnormalities, problems which lend themselves to judicious guidance and complete orthodontic therapy.

History of the Development of Orthodontics in Cleft Lip and Palate Subjects

Clefts of the lip and palate have probably afflicted the human race since prehistoric times. Unfortunately for science, archeological evidence of this malformation is remarkably sparse. The first cleft palate repair in the United States was performed by Stevens in 1827. One of the earliest employed intraoral appliances was the obturator. Fauchard, in 1786, made valuable contributions and innovations in prosthodontics, particularly in the area of obturators.

Two men stand out for their early contributions to the orthodontic and prosthodontic treatment of these deformities. Kingsley, who shares with others the claim to be the "father of orthodontia", wrote his classic textbook "A Treatise on Oral Deformities as a Branch of Mechanical Surgery" in 1897. This book featured the orthodontic appliances of the period, including jack screws, retainers, and arches with ligatures. Case published "A Practical Treatise on the Techniques and Principles of Dental Orthopaedia and Prosthetic Correction of the Cleft Palate" in 1921. The appliances described were all of the fixed type.

A considerable amount of cleft palate research, particularly longitudinal growth studies, has been conducted by orthodontists. Cleft palate orthodontics is no longer confined to the local movement of individual teeth; it also involves early treatment for the movement of the distorted maxillary palatal segments into a more normal spatial relationship.
The Maxilla in Cleft Lip and Palate Patients

It is generally accepted that the maxilla in cleft lip and palate children is deficient in vertical and anteroposterior dimensions (Graber, 1950; Ross and Johnston, 1972) (see Chapter 42). This may vary with the type and severity of the cleft. Clinical and radiographic observations indicate that there are morphologic differences in the character of the palatal defect from one patient to another both within specific cleft palate categories and between the different types of clefts.

The cleft appears to be present more often in the dentoalveolar area where the developing lateral incisor tooth would normally be located (between the maxillary central incisor and the cuspid). In all types of cleft palate except in the lip and alveolar group (or primary palate), the defect involves the premaxilla, the palatal processes of the maxilla, and the horizontal processes of the palatine bone. The disruption in the continuity of the bony palate contributes toward the abnormality in muscle attachments and function; there is also a resulting constriction of the palate and accompanying dental malocclusion.

In unilateral clefts the affected palatal segment is rotated medially, while the larger non-cleft segment is rotated upward and outward in the area of the dentoalveolar process adjacent to the cleft. This results in an overlapping of the palatal segments with the smaller palatal segment locked in behind the larger noncleft segment. In bilateral clefts the premaxilla may be advanced or turned in and upward. In both situations, however, the lateral palatal segments are usually rotated medially toward each other.

Since variations are noted in all clefts, each patient must be analyzed on an individual basis. In each patient the orthodontic approach must employ treatment procedures designed to bring the deformed dental arch within normal limits. Achievement of this goal often involves uncovering the true status of the cleft and the magnitude of the congenital maxillary deformity. Since there is both displacement and deficiency of tissue in cleft palate patients, the anatomical defect in each cleft lip and palate patient should be adequately defined as early as possible. The defect usually includes bony and soft tissue structures that may be deficient and/or displaced. Coupe and Subtelny (1962) demonstrated a deficiency of hard palate tissue in all types of clefts involving the hard palate. The deficiency was greatest in bilateral clefts, while unilateral clefts had the least. Although this is not true in all cases, it would appear that treatment procedures (surgical and/or orthodontic) in some cases are much more effective in producing a satisfactory result, while in others the reverse is true. This difference may reflect the degree of tissue deficiency with which the clinician must work and the difference in the spatial relationship of the parts to be treated. One of the basic differences between cleft palate children and noncleft palate children may be in the quantity of hard palate tissue. This finding may be evident at birth and become more manifest with growth and development. Such features as the width of the cleft, the extent of the cleft, and the spatial relationships of contiguous anatomical structures are important skeletal considerations that should be evaluated prior to orthodontic treatment. Clinical and radiographic records, which are invaluable for diagnostic and treatment planning, also serve as data for longitudinal evaluation over periods of growth and/or treatment.
The Mandible in Cleft Lip and Palate Children

Inequality in the growth of the jaws may occur. It may be the result of a genetic potential for continued growth of the mandible and/or a reduction of maxillary growth. The lower jaw has an inherent potential to develop into a Class I, II, or III skeletal mandible (Ross and Johnston, 1972). This factor in the presence of a hypoplastic maxilla can compound the incidence of facial concavity and resulting prognathism. Orthodontic treatment will not resolve skeletal problems evolving during later states of growth (Converse and coworkers, 1964), and these problems may be related in no way to the diagnosis and orthodontic treatment plan prescribed. In individuals with clefts of the lip and palate, it is not unusual to have satisfactory facial appearance at an early age, followed by deterioration in facial contour at a later age. Some patients with a cleft lip and palate have the potential for a mandible that may be smaller than that observed in a noncleft population. In this regard patients with a cleft palate may have a smaller mandible than that of the noncleft palate population (Borden, 1953). In the Pierre Robin anomalad one of the three factors comprising the clinical triad is mandibular hypoplasia or micrognathia. Growth of the mandible in the presence of a maxillary deformity compounds the problems in the overall treatment objectives from one year to another. It is only with increased knowledge about the growth of the maxilla and mandible in light of the existing deformity that we can become more secure in our therapeutic objectives on a continuing basis.

Dentition in Cleft Lip and Palate Patients

Dental anomalies occur frequently in cleft lip and palate patients (Bohn, 1963). A common example is the congenital absence of teeth, particularly the maxillary lateral incisors at the site of the cleft. An interesting yet inexplicable finding is the congenital absence of maxillary and/or mandibular second bicupsids. Since they develop remotely from the site of the cleft and have been found to occur in greater frequency in the cleft palate population, it becomes even more mystifying. One or all four bicupsids may be absent. In addition, the second bicupsids may show an abnormal pattern of calcification and development. Development of the second bicupsids has commenced as late as 6 to 8 years of age, ie, three to five years beyond the normal period of beginning calcification. Clinical examination of such a patient during the mixed dentition stage would lead one to conclude erroneously that these teeth are congenitally missing. These children must therefore be examined periodically, and treatment plans may have to be modified and often compromised, depending upon the severity of the cleft, the growth of the jaws, and the status of the developing deciduous and permanent dentition.

Another common dental aberration is the presence of supernumerary teeth. Cleft palate patients have a greater number of such teeth in contrast to their noncleft counterparts. These teeth are usually located adjacent to the cleft site; some emerge into the oral cavity, while others may remain unerupted within the maxilla. They may vary in size, shape, and location. Some are palatally positioned, while others are labial. Many of them are often removed to facilitate the treatment of the remaining dentition. Whenever possible, they may be maintained and used to carry a fixed appliance to expand the palatal segments. They also contribute toward maintaining the integrity of the dental arch and alveolar process. In some cases, where a lateral incisor tooth is missing, a supernumerary tooth may be retained to take the place of the missing incisor. The maxillary central incisors adjacent to the cleft in the noncleft palate
segment in unilateral cases are often found to be severely rotated and poorly calcified. In bilateral clefts both central incisor teeth may be equally hypoplastic and show varying degrees of rotation. The roots of these teeth may not appear to be normal in their development, and it occasionally appears that there is insufficient supporting alveolar bone. This is especially true in bilateral clefts in which the premaxilla is extremely mobile and there is relatively greater tissue deficiency. Nevertheless, these teeth should be retained and rotated into a normal position as early as possible.

Fixed appliances in the mixed dentition stage are effective in the treatment of rotated teeth. Aside from improving dental relationships within the dental arch and between individual teeth, the appliances establish a more favorable anatomical architecture under the repaired lip. Early management of these rotated teeth contributes toward improved stability of the involved teeth and of the palatal segment in which it is developing. In patients with malpositioned and malformed teeth, early rotation of these teeth is recommended with a plan to restore and utilize the teeth as additional abutment teeth. Early extraction of such teeth entails loss of part of the dentoalveolar process and the loss of dental units that can serve in expansion procedures to establish a more normal dental arch form.

Other frequently encountered dental abnormalities in cleft lip and palate children are fused teeth and variations in tooth size and location. Ectopic teeth are of primary concern, because some decision early in the management of the malocclusion must be made about the disposition of these teeth. Two factors might be at play: one is arch length-tooth material disparity, and the second is the abnormal site of development and eruption of these teeth. They may be palatally posed and completely blocked out of the dental arch; occasionally they may be transposed. In cleft palate patients such dental aberrations occur in conjunction with the existing maxillary skeletal anomaly and compel the orthodontist to modify and compromise his treatment objectives. X-ray, cephalometric, and panoramic films are helpful in diagnosis and treatment planning. Plaster models and photographs should also be taken.

**Stages of Treatment**

**The Newborn Period.** Until recent years orthodontic therapy for the cleft lip and palate child was usually not undertaken until after the eruption of all the deciduous teeth, at approximately 3 years of age. However, in parts of Europe and in the United States some clinicians began to institute correction shortly after birth.

The construction of an expansion prosthesis for infants with bilateral cleft lip and cleft palate was demonstrated by McNeil (1954), Burston (1958), and Harkins (1960). A bilateral cleft involving the lips, the alveolar process, and the palate is an extensive deformity creating esthetic and functional problems. Rehabilitative treatment necessitates both the restoration of facial contour and balance, labial mobility, the sublabial space, and the dental arch, and the separation of the oral cavity from the nasal and pharyngeal cavity.

The abnormal position of the infant's premaxilla complicates restorative measures and results. Various specific surgical methods have been advanced to obtain an adequate retropositioning of the premaxilla (see Chapter 44). These methods rely on the pressure of the surgically united lip to retropose the premaxillary process anatomically and functionally. Unfortunately, the desired results are seldom achieved (Harkins, 1960). In many of these cases
the surgeon finds it easier to correct the deformity if the premaxilla and maxillary arches are repositioned to a more favorable arch relationship. This treatment may be provided by a split prosthesis which is capable of moving and repositioning the maxillary segments. It may expand or contract the maxillary arch, depending on which direction the forces are applied.

As described by Harkins, the sequence of treatment when an expansion prosthesis is used is as follows:

1. Initial and secondary impressions.
2. Construction of the expansion prosthesis.
3. Resection of the vomer (now seldom done).
4. Placement of the expansion prosthesis in situ.
5. Surgical closure of the lip.
6. Surgical closure of the alveolar process after retroposition of the premaxillary process.
7. Prosthetic or surgical restoration of the palate at a later stage.

The initial impression is taken, or in some cases specially made acrylic trays from previous models of correct size may be used. From this preliminary impression, a more accurate self-curing acrylic tray is made and used to take a more definitive impression from which a final working model is made. All safety precautions are followed during the impression taking. The model is studied and designed for the placement of the expansion screws to be used. They are fixed in position, and the mechanism is covered with plaster and waxed to the model. The waxed model is processed in clear acrylic resin. After it has been processed, it is cut through the midline to the expansion screw. The prosthesis when polished is fitted to the patients' palate and the necessary adjustments are made. The prosthesis should not extend too high into the sulcus or posteriorly or it will irritate the palate.

If the prosthesis is to be used in conjunction with surgery, it is advisable to wire it in position; alternatively, some surgeons prefer to be able to remove it. To help the prosthesis become more retentive, denture adhesive is used. Rapid expansion, except in a case where surgery is performed, is contraindicated. The usual and advisable method is to turn the screw one notch every five or seven days, and this is equivalent to a 0.25-mm increase in the width of the appliance. The appliance not only will act as a retainer and prevent maxillary collapse but also will stimulate growth. The appliance also aids in the feeding problem and has a beneficial effect on future speech function. Lindquist (1963) pointed out that the abnormal swallowing pattern, which the baby with a palatal cleft is forced to adopt, may alter the motor action of the nerves to the muscles which are common to speech and deglutition. The resulting patterns of muscular action appear to play a role in the maintenance of the typical abnormal speech in some patients despite subsequent adequate surgical treatment.
Early orthodontics without surgical interference was reported by McNeil in 1956. He used a palatal appliance to keep the palatal segments apart before the palate was repaired. He felt that constriction of the maxilla could not be avoided following lip surgery. Therefore, he recommended repositioning of the parts prior to lip surgery; McNeil maintained that his appliance contributed toward bone growth and resulted in a narrowing of the hard palate cleft. He showed that in complete clefts of the primary and secondary palates the involved palatal segments could be moved into satisfactory alignment by using a series of split palatal appliances, specially constructed for the patient at specific age intervals. The splints are split in the midline and periodically realigned to move the palatal segments into a more normal anatomical relation. They are constructed by means of a sectioned plaster cast of the palatal segments. The segments are placed into the desired position, and a palatal appliance is constructed. The latter is worn by the neonate to move the maxillary segments during the functional activities of sucking and swallowing. Two or three appliances may be required over a period of six months to aid in obtaining the desired correction. Following orthodontic repositioning, the cleft lips is surgically repaired, and frequently a bone graft is inserted into the dentoalveolar area.

Burston (1958) described a technique similar to that of McNeil’s. The new concept of maxillary orthopedics included bone grafting to stabilize the palatal segments in the desired position (see Chapter 48). Forshall, Osborne and Burston (1964) reported that only about one-third of those treated subsequently maintained adequate form, while one-third showed disappointing results.

Another type of splint employed is one which incorporates the jack screw in the midline for arch expansion. An additional variation in the molding force is the use of an extraoral elastic band used by Desault (1791) and revived by Walker, Collito, Mancusi-Ungaro and Meijer (1966) and by Griswold and Sage (1966).

A preliminary lip adhesion has been advocated by Johanssen and Ohlssen (1961), Millard (1964), Spina (1964), Randall (1965), and Walker, Collito, Mancusi-Ungaro, and Meijer (1966) to bring the maxillary elements into satisfactory alignment before the lip is closed by surgical means.

Orthodontists who did not espouse the early bone grafting type of treatment procedure concluded that it was not advisable and should not be routinely followed (Pruzansky, 1955, 1964; Pruzansky and Aduss, 1964; Subtelny, 1966). One of the most important disadvantages is the postponement of the surgical correction of the cleft lip, which can cause psychosocial problems. It also does not preclude a relapse of the maxillary segments and the need for continued orthodontics during the formative years. Furthermore, it has been reported that collapse of the maxillary arch occurred in only 40 per cent of unilateral cleft patients studied by Pruzansky and Aduss (1964).

Although it is generally accepted that the forces exerted by the repaired lip musculature may displace one or both of the maxillary segments medially (Pruzansky and Aduss, 1964), it is an established fact that early orthodontic treatment can effectively reposition the malposed segments. As a result not only are the maldeveloped and displaced segments positioned more adequately but also the existing crossbite malocclusion is corrected (Subtelny and Brodie, 1954; Subtelny, 1966; Coccaro, 1970). Retention appliances are needed
in the transition from deciduous to permanent teeth, and additional periods of fixed appliance therapy are necessary until a full complement of permanent teeth is fully erupted and the teeth are in good alignment and occluding satisfactorily (Subtelny, 1966; Coccaro, 1970).

**Period of Deciduous Dentition.** One of the major clinical features common to many cleft lip and palate patients is the constricted and distorted maxillary arch. McNeil (1956), Nordin (1957), Schrudde and Stellmach (1959), and others felt that a constriction of the maxilla cannot be avoided after lip surgery. Pruzansky and Aduss (1967) have shown that other factors are responsible for collapse of the arch. Whether due to the modeling action of the lip following surgery or not, it is a skeletal factor orthodontists have to consider in planning treatment in these patients. Since the alveolar process of the cleft segment may move medially behind the noncleft segment, it should be noted that the character of the cleft tends to influence the form of the maxillary area. In unilateral cases, the smaller segment, ie, the cleft segment, is free and unattached to the vomer and nasal septum, while the noncleft segment, which is larger and includes a portion of the premaxilla belonging to the smaller segment, is rotated upward and outward in the premaxillary region. The larger segment is in contact with the vomer and nasal septum and may be influenced in its position by the growth potential of the septum. Therefore, the space between the two segments permits the smaller segment to become impacted by rotating medially, carrying with it the dentoalveolar process and developing dentition. The resulting crossbite is due to skeletal as well as dentoalveolar malpositioning. Early orthodontic correction in the child with a congenital cleft lip and palate has been recommended by many orthodontists in the United States and is initiated after the eruption of all deciduous teeth, at approximately 3.5 years of age.

The advantages of early treatment are many, particularly in the areas of function, esthetics, and speech. In addition, a foundation is provided for the support of the surgically reconstructed lip. The dentition must be in good condition, not only to permit the utilization of fixed orthodontic appliances but also to permit prolonged use of retention appliances. The repositioning of displaced palatal segments of the maxilla is dependent upon the presence of teeth, both deciduous and permanent. Since teeth serve to support the orthodontic appliance, dental care of deciduous teeth is imperative, and specialists in pediatric dentistry must be consulted. Cooperation with other professional disciplines helps toward fulfilling the total rehabilitative needs in cleft lip and palate patients at different age levels coincident with the changing character of the deformity.

The first phase of orthodontic therapy must be directed toward counteracting the adverse muscular forces (Harvold, 1949; Johnston, 1958; Burston, 1958; Glass, 1959). Orthodontic forces must expand (via rotation of cleft palatal segments that are not united because of the cleft) the palatal processes of the maxilla and the accompanying dentoalveolar processes. The expansion and rotation of maxillary segments is realistically achieved through orthodontic therapy. In the young patient, bony palatal segments yield to the orthodontic forces which are employed. By virtue of this maneuver, the unfused palatal segments are moved in a lateral direction. In some bilateral clefts in which lateral palatal segments are locked behind the premaxillary segment, an advancement of the premaxilla is indicated before an attempt is made to move the constricted palatal segments laterally. The added potential of enhancing maxillary growth is also always present when malposed and overlapping palatal processes are adequately positioned. If the impacted alveolar segments were allowed to remain
overlapping, they would serve to impede growth and contribute toward pressure resorption of the alveolar processes.

Studies have shown that presurgical orthodontics and bone grafting do not necessarily prevent the development of malocclusion (Derichsweiler, 1958). Other investigators (Subtelny and Brodie, 1954; Pruzansky and Aduss, 1967; Coccaro, 1970) have found a high percentage of orthodontic collapse, as represented by a crossbite in the deciduous dentition. Collapse of the maxillary arch is a factor in many of the cleft palate patients, and it has been shown to occur in 40 per cent of all cases in one study (Pruzansky and Aduss, 1967). It appears that the problems and the required treatment procedures must be evaluated over a period of time to weigh the effects of time and growth in each individual.

**Period of Mixed Dentition.** It should be stressed that early orthodontics in the deciduous dentition does not necessarily obviate the need for orthodontics at a later age. In fact, the reverse is true; permanent teeth, especially those adjacent to the cleft, are usually malposed and often severely rotated and poorly calcified. Consequently, orthodontics during the period of mixed dentition is necessary. Correction of these abnormalities should be done as soon as they become apparent. Banding and the use of arch wires appear to be the appliances of choice. The corrections are easily accomplished as soon as these teeth erupt and are maintained in their new position. In addition, the adverse influence of rotated and malpositioned maxillary teeth may be eliminated. Midline relationships are a fairly consistent problem, and it is often impossible to attain a correct midline relationship. Maxillary teeth may be in an anterior crossbite relationship with the mandibular incisors. In these cases an acrylic inclined plane secured to the mandibular incisors may add to the correction initiated by the bands and arch wire.

**Period of Adult Dentition.** Close observation of individuals with clefts should be continued until all permanent teeth have erupted into the oral cavity. By late adolescence the final orthodontic positioning of all of the permanent teeth should be completed. With the final phases of therapy, it becomes apparent that the early stages of therapy involve moving bony palatal segments, while the later stages are usually restricted to individual tooth movement. The extraction of teeth may be recommended to establish a balance between the number and size of dental units and the existing available dental arch lengths. The underdevelopment of the maxilla could be an etiologic factor. Judicious removal of mandibular first bicuspids may be required to obtain an adequate overbite and overjet relationship of the anterior teeth. Secondary bone grafting in the cleft site of the anterior maxillary alveolar process may be indicated following the late stages of orthodontic treatment. It may help to stabilize the segments of the maxillary arch and contribute toward maintaining final orthodontic results. It also enhances facial appearance, since it adds to the support of the floor of the nose and lip and minimizes the undesired depressed appearance noted in these areas.

Retainer appliances are used at various stages of treatment: (1) Following repositioning of palatal segments, retention is necessary to maintain the newly established palatal positions. Without such retention, there is a rapid return of the bony segments to their original positions. (2) Retainers also serve to obturate a palatal fistula and carry a replacement for missing teeth. Moreover, they serve to maintain spaces in the dental transitional period. (3) During the late stages of adolescence, some form of permanent retention appliance must be inserted to maintain the orthodontic results and often replace a missing tooth in the area of the cleft.
Conclusions

In the treatment of children with cleft lip and/or palate, the problems associated with growth and development of the skeletal and dentoalveolar processes of the maxilla and the extent of maxillary involvement by orofacial defects make it difficult to achieve a permanent result during any particular stage of physical development. The need for staged orthodontic therapy to obtain the optimum results throughout the formative years becomes more apparent.

The role of the orthodontist in cleft palate rehabilitation and the need for early orthodontic intervention to unlock impacted palatal segments and permit more normal growth have long been recognized. Several periods of treatment are necessary, beginning with the deciduous teeth and extending to the succedaneous teeth; long periods of retention are subsequently required. To unite and create a stable homogenous upper jaw, grafting procedures (McNeil, 1956) have been employed in association with retention appliances. The advocates of bone grafting maintain that results cannot be regarded as definitive until a permanent bite has been fully established (Johanssen and Ohlssen, 1961).

Thus, there are three rather important reasons for orthodontic treatment on a continuing basis from childhood through adulthood. First, there is the need to align distorted and constricted palatal segments of the maxilla. Secondly, impacted palatal shelves must be liberated to enhance dentoalveolar growth at the cleft site and contribute toward correcting existing crossbite dental relationships. The third reason is to maintain the gains made by expansion and dental alignment procedures.

The ideal method of documentation in these areas is on a longitudinal basis through photographic and radiographic records. Growth is apparent in malpositioned palatal segments following early orthodontic treatment. Once the impacted segments are free and positioned satisfactorily to reestablish a more normal dental arch, the alveolar and palatal surfaces of the maxilla can manifest more normal growth potential.

To maintain the gains made in palatal width and in dental arch form, it is essential to use fixed and/or removable retainers. Fixed retainers become obsolete with increasing loss of deciduous units during growth and development. Thus, one must rely upon removable appliances in the transition period.

Maintenance of orthodontic results appears to be difficult even in the presence of retainers and/or bone grafts, particularly during the formative years of skeletal and dental development. This finding may reflect the adverse impact muscular forces have upon palatal segments through the period of adulthood.

Though it is apparent that palatal and dental changes appear to be inevitable, most of the gains made in correcting palatodental abnormalities and in growth can be retained, and any slight relapse may be recovered by an additional period of orthodontic treatment.