A Comparison of the Effects of the Latham-Millard Procedure with Those of a Conservative Treatment Approach for Dental Occlusion and Facial Aesthetics in Unilateral and Bilateral Complete Cleft Lip and Palate: Part I. Dental Occlusion

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The purpose of this study was to compare the effect of the Latham-Millard presurgical orthopedics, gingivoperiosteoplasty, and lip adhesion protocol with conservative treatment (nonpresurgical orthopedics without gingivoperiosteoplasty) for palatal and dental occlusion in complete bilateral and complete unilateral cleft lip and palate. All patients were from the South Florida Cleft Palate Clinic. A retrospective dental occlusal study was conducted using serial dental casts that had been taken of patients from birth to 12 years of age. All surgical procedures, except for the secondary alveolar bone grafts in the conservative, nonpresurgical orthopedics group, were performed by D. Ralph Millard, Jr. Ralph Latham supervised the presurgical orthopedics cases. Samuel Berkowitz collected and analyzed all the serial records from 1960 to 1996. Among the patients with complete unilateral cleft lip and palate, 30 patients were treated with presurgical orthopedics, gingivoperiosteoplasty, and lip adhesion (the Latham-Millard protocol) and 51 patients were treated conservatively (i.e., nonpresurgical orthopedics without gingivoperiosteoplasty). Among the patients with complete bilateral cleft lip and palate, 21 patients were treated with the Latham-Millard protocol and 49 patients were treated conservatively. Conservative treatment was performed between 1960 and 1980. In patients with bilateral cleft lip and palate, a head bonnet with an elastic strip was used to ventroflex the protruding premaxilla. In all patients (unilateral and bilateral cleft), lip adhesion was performed at 3 months followed by definitive lip surgery at 6 to 8 months and palatal cleft closure between 18 and 24 months of age, in most cases. The Latham-Millard procedure was performed from 1980 to 1996; in bilateral cleft patients, it involved the use of a fixed palatal orthopedic appliance to bodily retract the protruding premaxilla and align it within the alveolar segments soon after birth. In all patients (unilateral and bilateral cleft), palatal alignment was also followed by gingivoperiosteoplasty and lip adhesion. Definitive lip surgery was performed between 6 and 8 months of age, and palatal closure was performed between 8 and 24 months of age using the von Langenbeck procedure with a modified vomer flap. All of the study participants had cleft lips and palates of either the unilateral or bilateral type; the unilateral and bilateral groups were further subdivided based on whether they had received the Latham-Millard protocol or the conservative treatment. It was then determined how many in each of these four basic groups had either anterior or buccal crossbites at four different age levels, when they were approximately 3, 6, 9, and 12 years of age. Although several children entered the study at or just before age 6, every patient in the 9-year-old and 12-year-old sample groups had been in the 6-year-old group and all of the 12-year-olds had been included in the immediate preceding age sample. Two-by-two chi-square tests were carried out within each cleft type (unilateral or bilateral) at each of the four age levels separately, to test whether the treatment groups (protocol versus conservative) differed in the frequency of cases with a given kind of crossbite (rather than not having that kind of crossbite). At every age level, a greater percentage of patients treated with the Latham-Millard protocol developed crossbites than did those treated more conservatively. This difference existed for both the anterior and buccal crossbites and for both unilateral and bilateral clefts. Chi-square tests of the treatment differences in crossbite frequency showed that in three quarters of the Latham-Millard protocol versus conservative treatment comparisons (12 out of 16), a significantly greater frequency of crossbite cases occurred after

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the Latham-Millard protocol treatment as compared with after the conservative procedure. The chi-square values for the differences in outcome between the two kinds of treatment procedures were greater for the anterior crossbites than for the buccal crossbites, suggesting that the Latham-Millard protocol, relative to the conservative method, was more likely to have an adverse effect on the anterior crossbites than on the buccal crossbites. For those patients born with a bilateral cleft, the differences in crossbite frequency between the protocol and the conservative treatment were statistically significant for patients with an anterior crossbite but not for patients with a buccal crossbite. The analysis shows that in complete bilateral and unilateral cleft lip and palate, the frequency of the anterior crossbite and (except for ages 3 and 12) the buccal crossbite is significantly higher with the Latham-Millard presurgical orthopedics, gingivoperiosteoplasty, and lip adhesion protocol compared with the conservative, nonpresurgical orthopedics without gingivoperiosteoplasty treatment. The exception in the bilateral buccal case may be attributed to the small experimental sample size, which brings down the confidence level. (*Plast. Reconstr. Surg.* 113: 1, 2004.)

One of the most widely debated areas in the treatment of cleft lip and palate involves the use of presurgical orthopedics and periosteoplasty with lip adhesion, a protocol designed by Ralph Latham (orthodontist) and D. Ralph Millard, Jr.[1,2] (plastic surgeon). Latham and Millard contend that their procedure is superior to a conservative, nonpresurgical orthopedic treatment for producing more aesthetically appealing lip/nose surgical results while still allowing for good midfacial growth and dental occlusion in patients with complete unilateral or bilateral cleft lip and palate. This study compared the dental occlusion of the Latham-Millard procedure with that of conservative, nonpresurgical orthopedic treatment, which Millard had been using between 1960 and 1980.[3] Proponents of the Latham-Millard procedure and others—who may not resort to a lip adhesion but who still use the same presurgical orthopedic procedure designed by Latham in patients with complete bilateral cleft lip and palate for forcefully retracting the protruding premaxilla—favor the attainment of improved facial aesthetics and palatal arch alignment soon after birth with or without periosteoplasty. They speculate that the early aesthetic benefits will remain as the face grows and develops.[4–7]

In complete unilateral and complete bilateral cleft lip and palate, treatment with presurgical orthopedics is usually followed by periosteoplasty, with the expectation that the resulting bone bridging will avert the need for secondary alveolar bone grafts at a later date.

It is not a simple or a lightly assumed task to offer a brief challenging the rationale for presurgical orthopedics and periosteoplasty for infants with complete unilateral or complete bilateral cleft lip and palate. Advocates of presurgical orthopedics, gingivoperiosteoplasty, and lip adhesion, or a variant of it, are few but well respected. Their proposed goal of making things right and whole as early as possible seems sensible and has great emotional appeal.

This article is the first of a two-part serial retrospective dental occlusal and facial study. The study covers more than 40 years of recording with serial dental casts and lateral cephaloradiographs the sequential influences of both presurgical orthopedics and conservative, nonpresurgical orthopedics on palatal development and anterior and buccal dental occlusion. Part I of this study used serial dental casts to determine the extent of anterior and buccal crossbites. Detailed dental occlusal analyses of these records tested the efficacy of the presurgical orthopedics procedure compared with the conservative treatment utilized by Millard and Berkowitz from 1960 to 1980, before the era of presurgical orthopedics. Part II of this study will analyze facial changes using serial lateral cephaloradiographs.

Materials and Methods

Cases of complete unilateral or bilateral clefts of the lip and palate, treated by either presurgical orthopedics or nonpresurgical orthopedics, were chosen from the files of the longitudinal facial and palatal growth studies of the Miami Craniofacial Anomalies Foundation. Patients were from the South Florida Cleft Palate Clinic of the University of Miami School of Medicine. D. Ralph Millard, Jr., performed lip, nose, and palatal surgical procedures in both test samples. Secondary alveolar bone grafts and maxillary and/or mandibular osteotomies and maxillary distraction osteogenesis were performed by S. A. Wolfe. Samuel Berkowitz documented growth changes with dental casts, lateral cephaloradiographs, panoramic radiographs, and photographs, and performed all treatment orthodontics other than presurgical orthopedics.[4,6] Berkowitz treated a number of the children in the presurgical orthopedics group who had extensive anterior crossbites starting when they were

about 9 years of age; therefore, beginning at this age, there is a reduction in the frequency of cases of anterior crossbite.

Presurgical Orthopedics with Lip Adhesion and Gingivoperiosteoplasty

Ralph Latham supervised the plastic surgery residents in the manipulation of the palatally pinned presurgical orthopedic appliance (Figs. 1 and 2). Another orthodontist later performed the same relatively simple procedure. Because of the training and close supervision involved in the treatments given, there was relatively little variation in this procedure during the years covered by the presurgical orthopedics data. In complete bilateral cleft lip and palate cases, the appliance mechanically expands the lateral palatal segments, allowing for the retraction of the protruding premaxilla into position within the alveolar arch (Figs. 3, 4, and 5). In complete unilateral cleft lip and palate cases, the mechanical forces bring the premaxillary portion of the larger segment mediopalatally, and in most instances the lesser segment is carried forward 2 to 3 mm to make contact with the larger segment (Fig. 6). Afterward, the floor of the nose is surgically closed, and a periosteoplasty is performed to permit the migration of alveolar osteoblasts to bridge the alveolar gap space. After the premaxillary retraction, a lip adhesion is performed, followed 6 to 8 months later by definitive lip surgery with "forked" flaps.

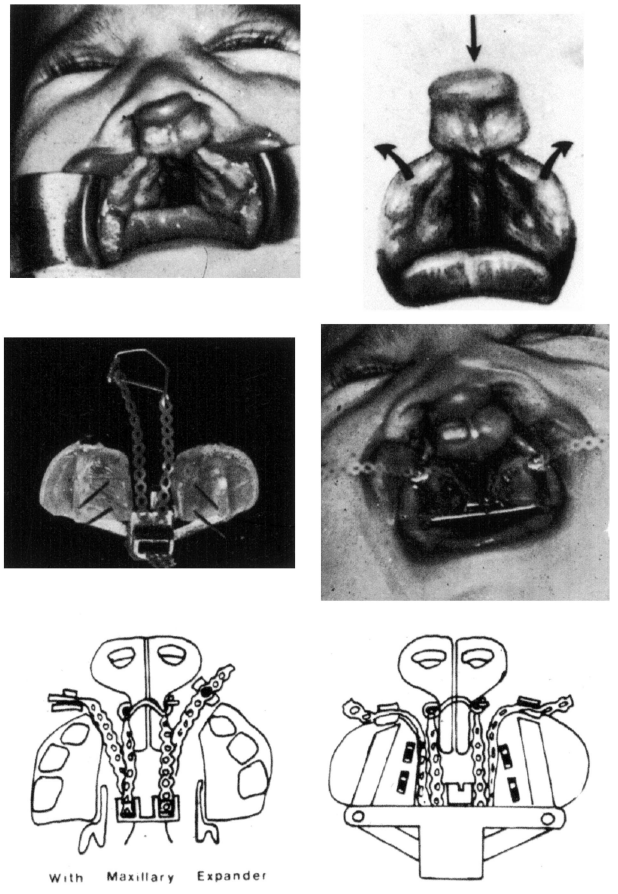

FIG. 1. Latham's presurgical orthopedic appliance for complete bilateral cleft lip and palate. The elastic chain creates the activating forces to retract the premaxilla while expanding the palatal segments. The posterior segment is pinned to the palate for approximately 2 weeks. The premaxillary pins, which are pulled by the elastic chain, are positioned anterior to the premaxillary vomerine suture.

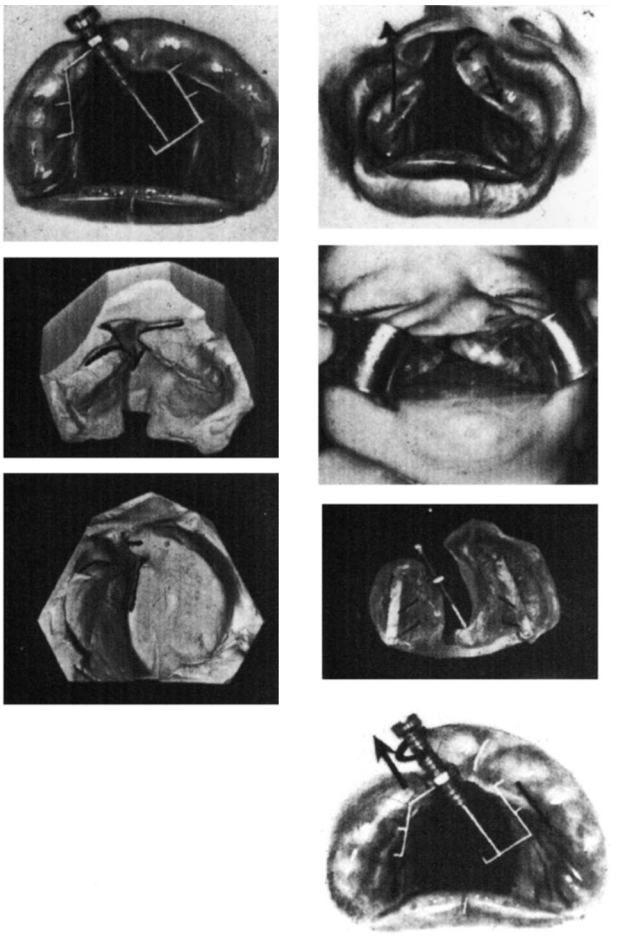

FIG. 2. Latham's presurgical orthopedic appliance for complete unilateral cleft lip and palate. The screw knob controls the movement of the pinned appliance. The premaxilla is bodily rotated mediopalatally while the cleft lesser segment is moved anteriorly approximately 2 to 3 mm to make contact with the smaller cleft segment.

Conservative, Nonpresurgical Orthopedics Treatment

In complete bilateral cleft lip and palate cases, the protruding premaxilla is ventroflexed by the forces generated by a head bonnet with an elastic strip positioned across

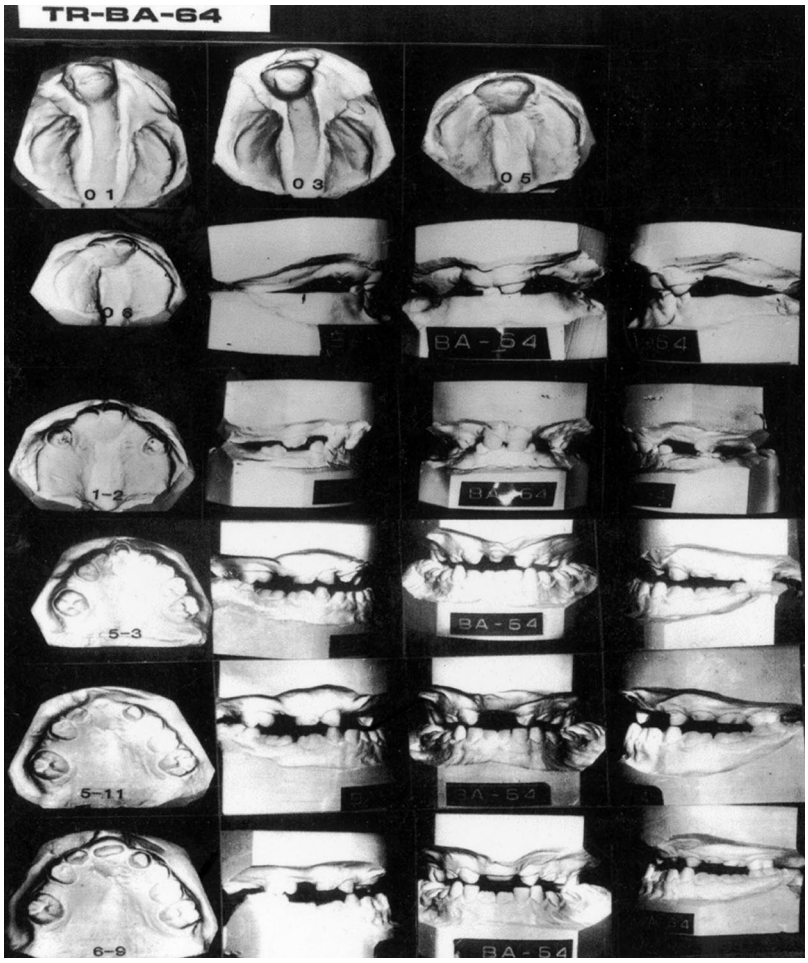

FIG. 3. Serial dental casts of a patient (TR-BA-64) with complete bilateral cleft lip and palate treated with presurgical orthopedics. The retruded premaxilla was positioned within the dental arch soon after birth, and lip adhesion was followed by a periosteoplasty. The palatal cleft was closed at 20 months of age. At 2 years, the anterior teeth were in tip-to-tip relationship with an open bite. Each following set of casts show a worsening anterior crossbite, which could not be corrected by a protraction facial mask worn for 2 years.

the prolabium, which is followed by lip adhesion surgery. No attempt is made to bodily retract the premaxilla and place it within the alveolar arch. Palatal cleft closure using a von Langenbeck procedure with a modified vomer flap is performed when the patient is between the ages of 18 and 36 months, depending on the size of the cleft space. In nonpresurgical as well as presurgical orthopedic cases, palatal expansion is sometimes used when the patient is 5 to 6 years old to correct the buccal crossbite.

In both presurgical and nonpresurgical orthopedics patients, orthodontic appliances are used to align the anterior teeth. In nonpresurgical orthopedics cases, orthodontic appliances are used before bilateral or unilateral secondary alveolar bone grafting. In presurgical orthopedics cases, anterior crossbite correction with full orthodontic appliances and a protraction facial mask is initialized when the patient is 8 to 9 years old, when one or both of the permanent central incisors have erupted. At this age, an attempt is made to correct the posterior occlusion. None of the test groups were in class III buccal occlusion at this age. Standard orthodontic treatment follows to align all the permanent teeth. In complete unilateral and complete bilateral cleft lip and palate, lip adhesion is mostly performed when the patient is 3 months old in both treatment protocols, followed by definitive lip surgery when the patient is 6 to 8 months old.

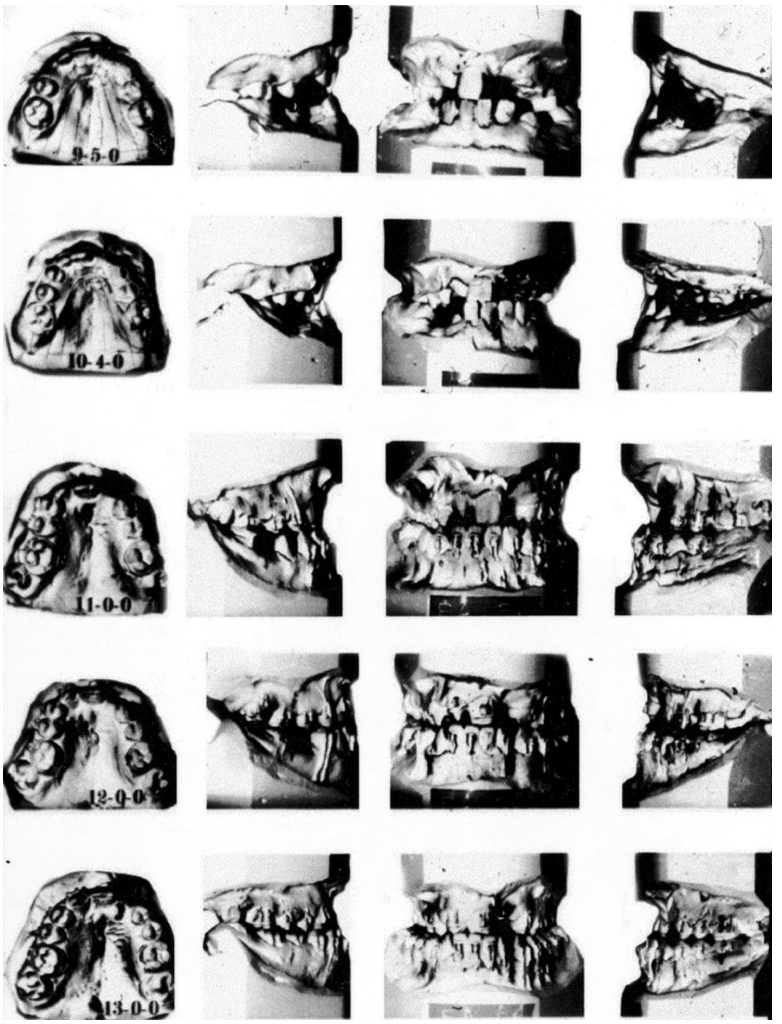

FIG. 4. Serial dental casts of same patient shown in Figure 3 (TR-BA-64). When the patient was 15 years old, maxillary distraction osteogenesis was performed to advance the maxilla. Both lateral incisors and a central incisor spaces were closed due to the early positioning of the premaxilla adjacent to the lateral palatal segments at birth. These spaces cannot be recovered to establish upper to lower anterior arch congruency because the gingivoperi-osteoplasty prevents the opening of the cleft spaces to increase anterior arch length between cuspids.

DISCUSSION

Since 1961, Millard and Berkowitz have been associated with the South Florida Cleft Palate Clinic, where presurgical orthopedic treatment was not being used. Millard has always been a strong supporter of the importance of serially documenting treatment outcomes with lateral cephalometric radiographs, dental casts, panoramic radiographs, and facial/intraoral photographs. To that end, they have worked diligently.

After 20 years of using nonpresurgical orthopedics before using the presurgical orthopedics, gingivoperiosteoplasty, and lip adhesion treatment procedure, Millard published an operational plan to investigate and record facial-palatal changes when utilizing the Latham procedure.[8] Today, Berkowitz has assembled an extensive collection of serial records that have always been available for review by any interested party. After reviewing the presurgical orthopedics serial case records, Kai Henkel,[9] a visiting professor of plastic surgery from Rostok, Germany, and K. Gundlach published a review stating that the procedure resulted in unsatisfactory facial aesthetics and dental function.

After 40 years of recording facial, palatal,

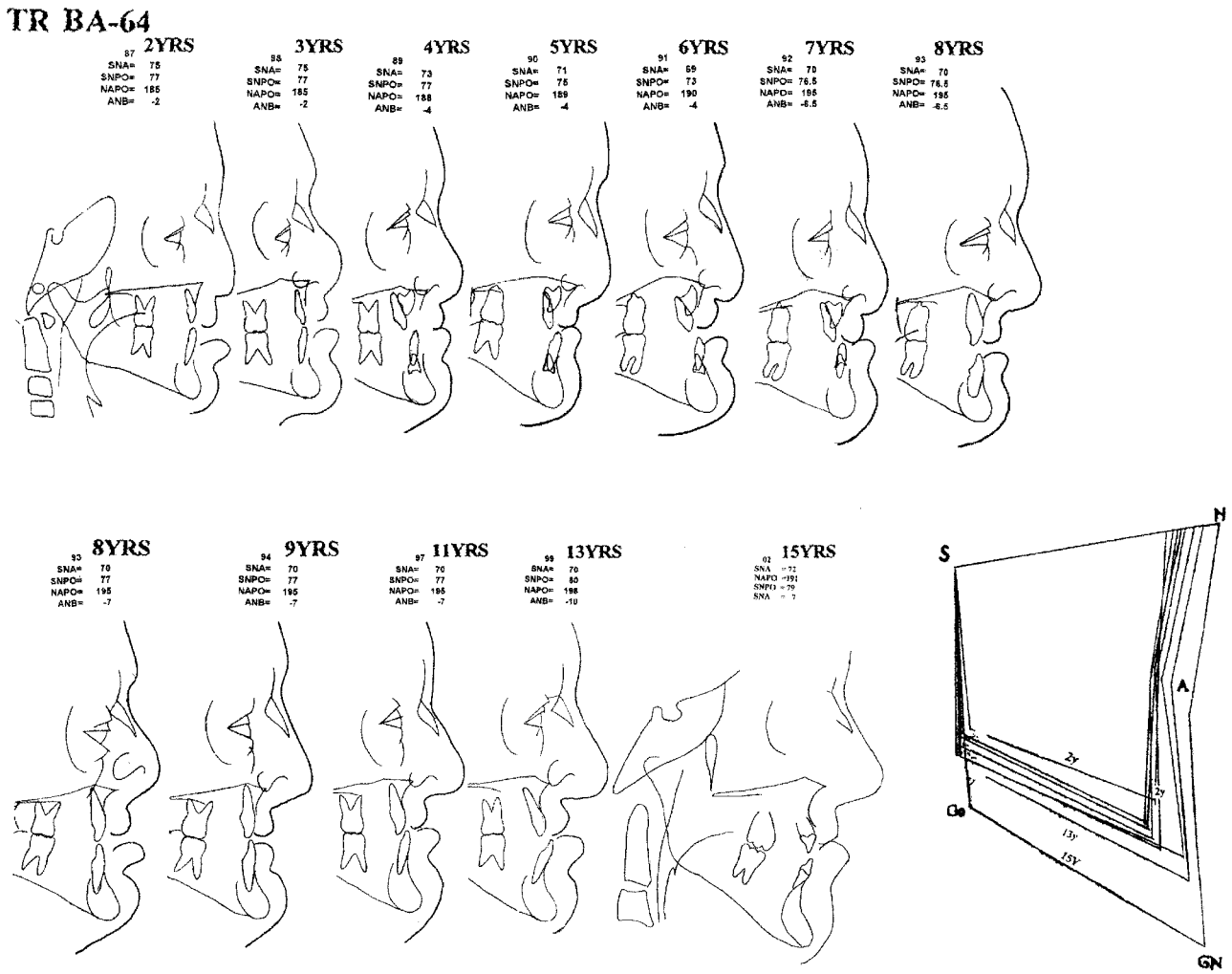

FIG. 5. Serial lateral cephaloradiographs of the same patient shown in Figures 3 and 4 (TR-BA-64). There is a class I posterior occlusion. The recessive midface was noted at 4 years of age and remained through all the subsequent follow-up ages. The last tracing shows the concave profile even after 13 mm of advancement by distraction osteogenesis, which created severe hypernasality. Each cephaloradiograph was superimposed on the sella-nasion (*SN*; the anterior cranial base) and registered at sella (*S*), creating a facial polygon that showed the stability of the concave facial profile. Two years of using protraction facial mask mechanics failed to advance the maxilla. The *polygon* represents the face after distraction osteogenesis. Mandibular setback will be performed at a later age, but the midface will still be recessive when it is compared with the anterior cranial base.

and dental growth changes in presurgical and nonpresurgical orthopedics cases, the authors of this brief believe that criticism is in order for a clinical procedure whose outcome results have now been adequately reviewed using serial objective records.

It is unfortunate that a controversy still exists as to the utility of presurgical orthopedics, gingivoperiosteoplasty, and lip adhesion or similar treatment with or without lip adhesion 20-plus years after its introduction, and after the critiques it has undergone by Berkowitz.[3] First, Georgiade and Latham[10] and Latham[11–13] have failed to publish any outcome studies. More recently, Millard and Latham have published a limited outcome report using Berkowitz's palatal cast records.[6] Millard and Latham's coauthors, Huifen, Spiro, and Morovic, performed linear measurements of the changing palatal size instead of analyzing the relative growth of the opposing jaws by reviewing the dental occlusion.

In their chapter supporting the presurgical orthopedics procedure for patients with complete bilateral and complete unilateral cleft lip and palate, Dufresne and So refer only to Millard's original introductory statements about the presurgical orthopedics procedure in *Cleft Craft*[1] and list no other supporting references, yet they advocate its use.[5] Cutting and Grayson limited their presurgical orthopedics report to the effect of periosteoplasty in successfully pro-

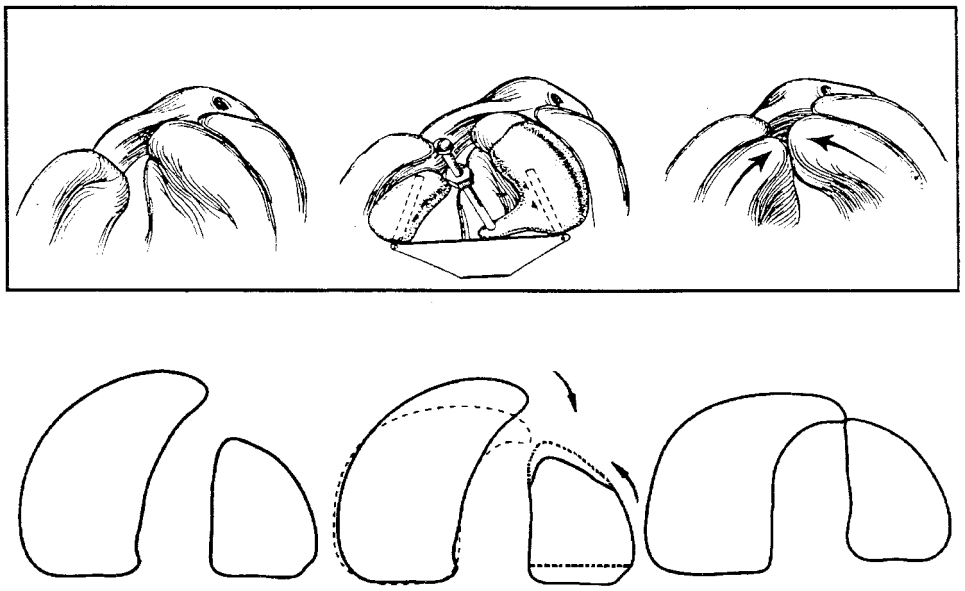

FIG. 6. (*Above*) According to Latham, the mode of action of the appliance used in complete unilateral cleft lip and palate is the medial movement of both segments toward each other (Dufresne, C. R., and So, H. I. S. Facial clefting malformations. In C. R. Dufresne, B. S. Carson, and S. J. Zinreich (Eds.), *Complex Craniofacial Problems*. London: Churchill Livingston, 1992. P. 209.). None of our unilateral cleft cases showed this pattern of movement. The actual movement of the palatal segments in unilateral cleft, when activated with the Latham appliance, is shown *below*. The premaxillary portion of the noncleft segment is bent mediopalatally, while the lesser-cleft segment is carried slightly forward, into contact.

ducing bone bridging of the alveolar cleft, but they made no mention of its effect on dental occlusion.[14,15]

In a preliminary report, Berkowitz[3,16] compared Millard's presurgical orthopedics, gingivoperiosteoplasty, and lip adhesion protocol with outcomes of Millard-Berkowitz's conservatively (nonpresurgical orthopedics) treated complete bilateral cleft lip and palate cases. That comparative outcome study confirmed the negative effects of presurgical orthopedics on facial aesthetics and dental occlusion. The study presented herein expands on that report.

In 1996, Berkowitz and Latham were asked by the American Cleft Palate–Craniofacial Association program committee to debate the utility of presurgical orthopedics at their annual meeting in San Diego, California. At that meeting, Berkowitz and LaRossa (plastic surgeon) presented long-term case reports that were critical of the procedure, but no supporting case studies were forthcoming from Latham and Morales (plastic surgeon).

Many clinicians who advocate the use of Latham's protocol or any other presurgical orthopedics treatment state that one benefit of the appliance is that it prevents "collapse" of the lateral palatal segments. The frequent use of the word "collapse" to describe palatal arch relationships after neonatal lip surgery is unfortunate and needs to be better understood. The term is misleading because it conjures up an unwarranted sense of foreboding.

The word "collapse" was introduced into the cleft treatment lexicon in the 1960s by some surgeons and orthodontists to describe the palate's physical state after the lip has been united, which results in medial palatal movement of overexpanded palatal segments. They evidently did not realize that in complete lip and palatal clefts, the resulting medial palatal movement (molding) is beneficial because it reduces palatal cleft size and corrects the relationship of the overexpanded palatal segments. Serial studies have shown that overlapping palatal segments in the deciduous and mixed dentition are of no clinical importance.

The word "collapse" implies that this condition is bad and should be prevented. However, after years of analyzing serial dental casts, many orthodontists have concluded that establishing lip muscle continuity leads to *good* geometric palatal changes, no matter their temporary neonatal geometric relationship. Overlapped segments do not impede normal palatal growth, and in most cases, such overlapped

segments can easily be properly realigned using relatively simple orthodontic appliances. Cleft segments in posterior crossbite at an early age are not indicative of future palatal maldevelopment. Since the width of the cleft space influences the type and timing of surgical palatal closure, one would prefer to have a small cleft space before palatal surgery to reduce the possibility of creating growth-inhibiting scarring while producing a normal palatal vault space.

In contrast to patients treated with conservative, nonpresurgical orthopedics, patients treated with presurgical orthopedics and periosteoplasty require extensive and costly orthodontic treatment to correct the anterior crossbites, regain lateral incisor spaces, and achieve upper to lower anterior arch congruency. The degree of facial and palatal distortion is often so extensive in presurgical orthopedics cases that additional surgical intervention is necessary at a later age. Some parents have reported that their children experienced psychosocial problems due to the lack of peer acceptance of the concave facial profile.

Presurgical Orthopedics in Complete Bilateral Cleft Lip and Palate

The protruding premaxilla is bodily retracted and placed in excellent alignment within the alveolar segments (Figs. 1 through 5 and Table I). Since no lateral flexion of the nasal septum has been seen in computed tomography scans, it was concluded that the premaxilla is "telescoped" posteriorly at the premaxillary vomerine suture (Fig. 7). The bending at the premaxillary vomerine suture is also seen in complete unilateral cleft lip and palate cases treated with presurgical orthopedics (Fig. 6). The premaxillary vomerine suture is not observed in follow-up palatal radiographs after presurgical orthopedics treatment (Fig. 8).

Figure 6 shows the error of palatal segmental movement in complete unilateral cleft lip and palate cases treated with presurgical orthopedics. Our three-dimensional analysis of the unilateral cleft palatal arch changes demonstrates that the premaxillary portion of the noncleft segment is brought mediopalatally while the smaller cleft segment is advanced, resulting in the loss of the lateral incisor space. This explains why an anterior dental crossbite is most likely to result.

Millard[1] has written that premaxillary retraction and periosteoplasty might have a negative effect on palatal growth, but he nevertheless believes this trade-off is acceptable to obtain early aesthetics, to close the floor of the nose, and to avoid the need for secondary alveolar bone grafting.

The desire of some surgeons to establish a child's well-balanced, aesthetically pleasing lips and nose soon after birth is understandable. However, extensive facial growth studies make clear that this should not be the top priority—that is, at the cost of good midfacial growth, dental occlusion, and speech at adolescence.[3,17–27] All of these goals should be possible without sacrificing one objective for another.

This comparative study contradicts the belief that performing well-designed lip/nose surgery on newborns using Latham's presurgical orthopedics to achieve early facial aesthetics while damaging palatal growth sites will lead to excellent adult facial aesthetics and dental function. The supporters of presurgical orthopedics suggest that should the face fail to grow well, it can be easily corrected without far-reaching consequences, such as poor self-esteem as a result of having a retrusive midface. This condition does not lend itself easily to correction by midfacial surgery alone. Extensive postsurgical psychosocial therapy may be

TABLE I

Total Number of Cases at Each Age Level in Presurgical and Nonpresurgical Orthopedics Treatment Groups

	Approximate Age of Participant				
	3 Years	6 Years	9 Years	12 Years	Total Sample
Unilateral cleft					
POPLA treatment	30	43	34	18	125
Non-POPLA treatment	51	54	46	33	184
Bilateral cleft					
POPLA treatment	21	20	15	9	55
Non-POPLA treatment	49	49	40	35	173

POPLA, presurgical orthopedics, gingivoperiosteoplasty, and lip adhesion.

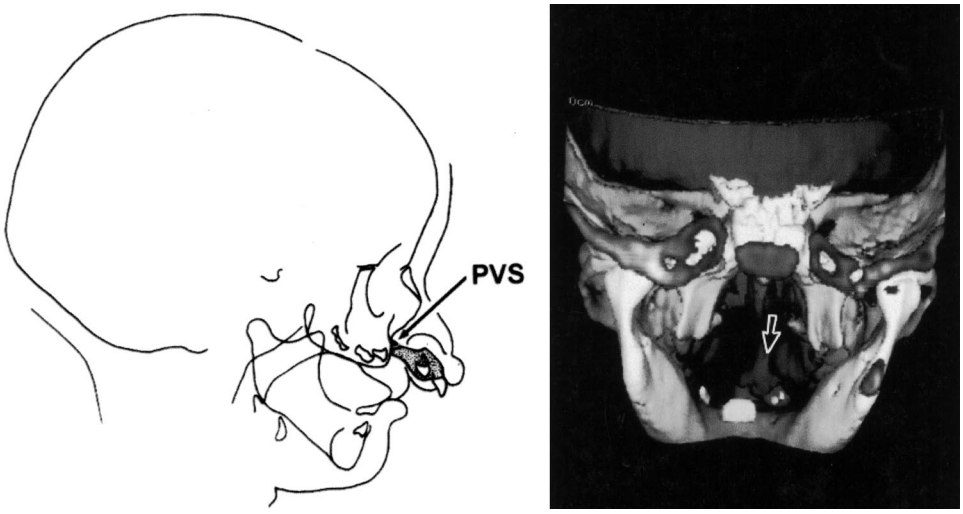

FIG. 7. (*Left*) Lateral cephalometric tracing of a newborn with a complete bilateral cleft lip and palate shows the location of the premaxillary vomerine suture (*PVS*) posterior to the protruding premaxilla. (*Right*) Frontal computed tomography scan of a patient with complete bilateral cleft lip and palate who was treated with the presurgical orthopedics, gingivoperiosteoplasty, and lip adhesion protocol. Only the left palatal segment is fused to the premaxilla with a bone bridge. Note the premaxilla "telescoping" at the premaxillary vomerine suture (*arrow*), the junction with the nasal septum.

FIG. 8. (*Left*) Palatal radiograph of a patient with complete bilateral cleft lip and palate who was conservatively treated at birth with a head bonnet with an elastic strip over the protruding premaxilla. The premaxillary vomerine suture was still open years later. (*Right*) Palatal radiograph after premaxillary retraction with a Latham appliance shows a synostosis of the premaxillary vomerine suture.

necessary in children with inadequately formed faces.[28]

In presurgical orthopedics cases, a buccal crossbite mostly involves the deciduous cuspid. The percentage of anterior crossbite cases increases with time (Figs. 9 and 10). In some presurgical orthopedics cases, when the premaxilla is not placed precisely within the arch, less bone bridging and fewer anterior crossbites occur. None of the cases show a class III buccal (posterior) occlusion. In complete bilateral or unilateral cleft treated with presurgical orthopedics, the anterior dental crossbite is always due to the manipulated premaxilla's retrusive position, which is never self-correcting or which could not be corrected orthodontically in the deciduous or, in most cases, even in the permanent dentition. In vertically growing faces, the anterior crossbite is orthodontically correctable in most cases. When the mandible grows forward, as it does in most faces, the anterior crossbite worsens, often requiring maxillary advancement surgery to create a proper dental overjet.

Serial cephalometric tracings of a typical complete bilateral cleft case (Fig. 5) show an early retrusive midface in the deciduous dentition, which creates an anterior crossbite with a

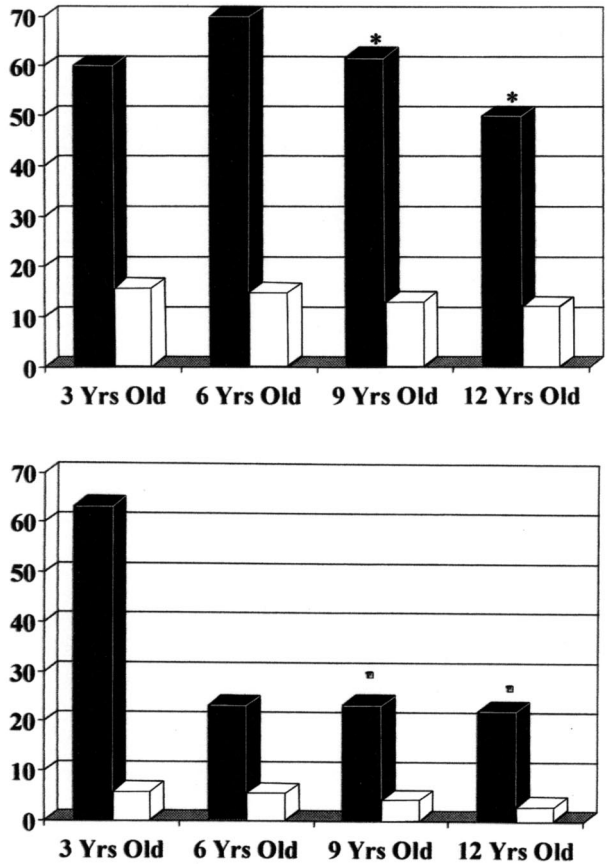

FIG. 9. The charts report the percentage of children with unilateral cleft lip and palate receiving presurgical or nonpresurgical orthopedics, by crossbite. At every age level, a greater percentage of youngsters treated with presurgical orthopedics developed crossbites than did those treated with nonpresurgical orthopedics (■, presurgical orthopedics; □, nonpresurgical orthopedics). This difference existed for both the anterior crossbite (*above*) and the buccal crossbite (*below*). *Some of the worst crossbite cases in the presurgical orthopedics group were treated by Berkowitz starting at about 9 years of age, thereby reducing the frequency of crossbite in this group beginning at this age level.

concave facial profile that worsens with time. An extensive cephalometric report will be forthcoming in part II of this overall study. In these complete bilateral and unilateral cleft cases, the upper face and the lower face gradually grow forward, but the palatal length between the first molars and the incisors remains constant (Figs. 11, 12, and 13). In most cases, Le Fort I surgery or maxillary advancement with distraction osteogenesis is necessary, as it was in this bilateral cleft case. In the presurgical orthopedics series, maxillary distraction osteogenesis was seldom utilized in unilateral cleft cases. This surgery results in immediate hypernasality due to an increase in pharyngeal depth leading to velopharyngeal incompetency. The hypernasality slowly diminishes in some cases within 1 year, but it was not completely absent in any of these cases.

In the bilateral cleft lip and palate group, 57 percent of patients treated with presurgical orthopedics, but only 18 percent of the nonpresurgical orthopedics–treated patients, exhibited an anterior crossbite at 6 years of age (Fig. 10, *above*, Figs. 11 through 13, and Table I). Posterior (buccal) crossbites are not always related to presurgical orthopedics (Fig. 10, *below*). The treatability of buccal crossbites is also influenced by the extent of scarring created by the surgical cleft closure procedure. If buccal crossbites are present, some may be easily corrected by 6 to 9 years of age in both bilateral

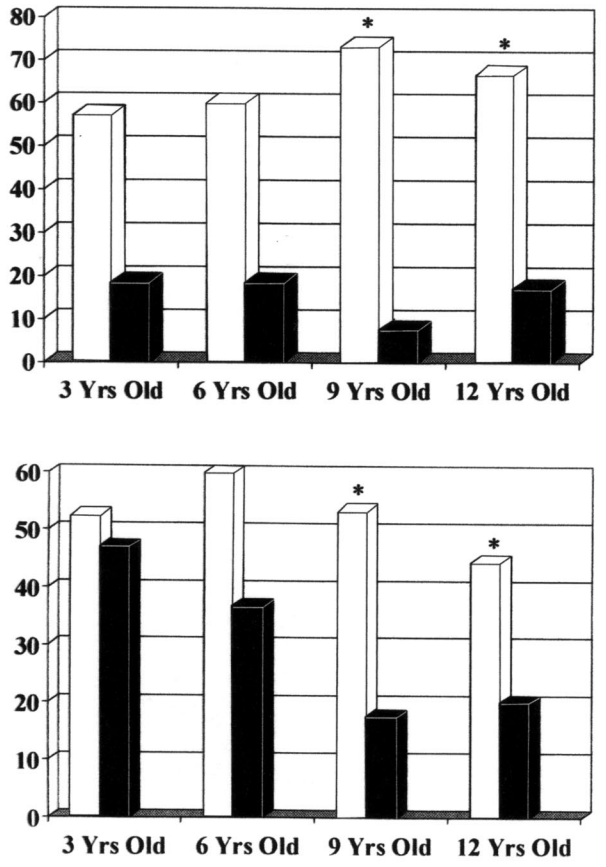

FIG. 10. The charts report the percent of children with bilateral cleft lip and palate receiving presurgical or nonpresurgical orthopedics, by crossbite. At every age level, a greater percentage of youngsters treated with presurgical orthopedics developed crossbites than did those treated with nonpresurgical orthopedics (□, presurgical orthopedics; ■, nonpresurgical orthopedics). This difference existed for both the anterior crossbite (*above*) and the buccal crossbite (*below*). *Some of the worst crossbite cases in the presurgical orthopedics group were treated by Berkowitz starting at about 9 years of age, thereby reducing the frequency of crossbite in this group beginning at this age level.

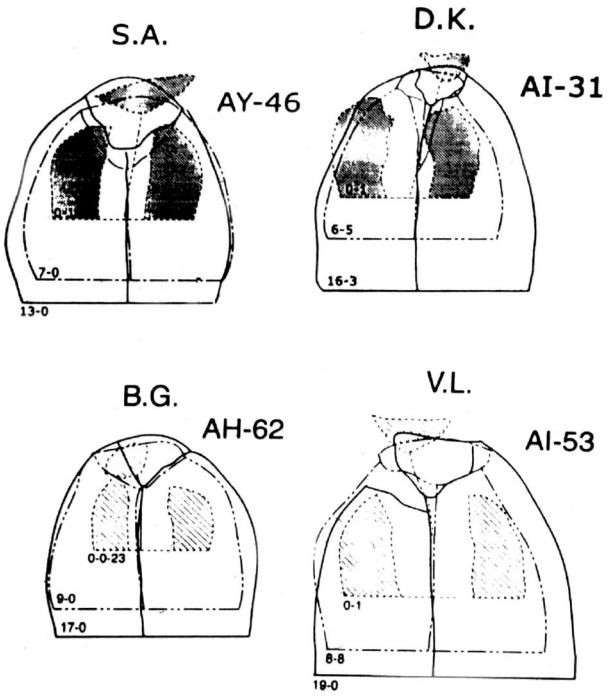

FIG. 11. Superimposed palatal cast tracings of the hard palate of four patients were acquired using a three-dimensional electromechanical digitizer. In each tracing, the alveolar ridge is the lateral border. The tracings are superimposed horizontally at the rugae and registered vertically on the vomer line. The area and extent of palatal growth changes are shown. In these bilateral cleft patients treated with nonpresurgical orthopedics, the premaxilla remained at the same relative position within the palatal segments at all later ages as it was at birth. The palate increased in size in all three dimensions but mainly posteriorly to accommodate the erupting permanent molars.

and unilateral cleft. As in cases of bilateral cleft, the unilateral cleft shows slight anterior palatal growth. Most palatal growth occurs posteriorly to accommodate the developing molars (Figs. 11, 12, and 13).

Presurgical Orthopedics in Complete Unilateral Cleft Lip and Palate

Early anterior dental crossbite in the deciduous dentition is associated with the loss of the lateral incisor space brought on by presurgical orthopedics treatment (Figs. 8, 14, and 15 and Table I). This results from the mediopalatal positioning of the premaxillary portion of the larger noncleft segment, which is brought into contact with the forward-positioned lesser-cleft segment. The following periosteoplasty creates extensive bone bridging in more than 80 percent of the cases.

Presurgical orthopedics patients have a greater transverse posterior arch width earlier than what is observed in nonpresurgical orthopedics patients. This is due to the palatal appliance preventing the neonatal overexpanded lateral segments from molding together and closing off most of the palatal cleft space. There is no clinical advantage for maintaining this increased palatal width at this early age, since presurgical and nonpresurgical patients will eventually attain ideal buccal occlusion after use of relatively simple orthodontic appliances.

An anterior dental crossbite with some degree of midfacial retrusion occurs in 60 percent of the unilateral cleft presurgical orthopedics patients by 6 years of age (Table I and Fig. 10, *above*), whereas only 17 percent of nonpresurgical orthopedics–treated patients experience an anterior crossbite (Fig. 10, *above*). In some presurgical orthopedics cases that did not result in an anterior crossbite, the lateral segments were not in contact at the time of periosteoplasty. Slight or no bone bridging with a good lateral incisor space is associated with good incisor overjet with no midfacial retrusion. The loss of the lateral incisor space can be anticipated, since alveolar bone is lacking in all cleft alveoli at birth, and for any bone bridging to occur, the alveolar segments need

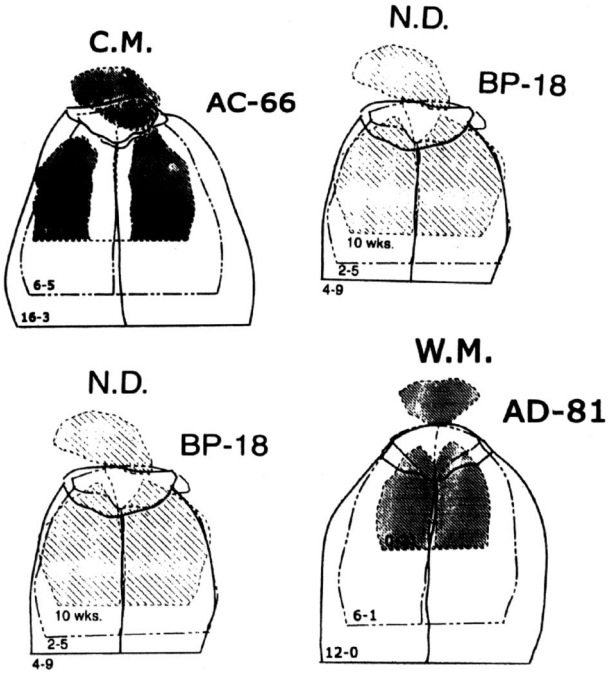

FIG. 12. Superimposed palatal cast tracing of the hard palate of four presurgical orthopedics–treated bilateral cleft patients. These tracings show that the retruded premaxilla, positioned within the palatal arch, following gingivoperiosteoplasty, does not change with growth. It remains retruded. (Details of the cast tracings are described in legend 11.)

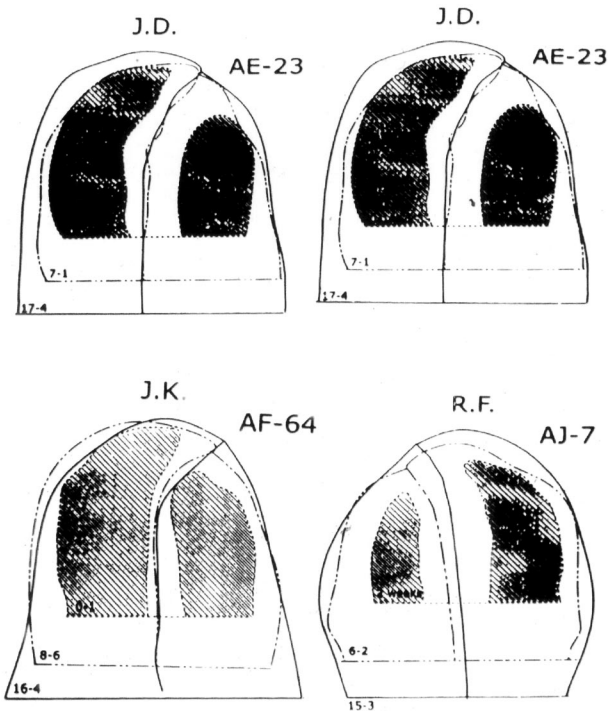

FIG. 13. Superimposed palatal cast tracing of the hard palate of four unilateral cleft patients treated with nonpresurgical orthopedics. There was some anterior palatal growth, but most of it occurred posteriorly with the development of the permanent molars. At birth, the cleft alveolar space was relatively small. The medially positioned cleft palatal segment was brought laterally during treatment to align the alveoli of both segments. These cases illustrate that cleft palatal segments may be significantly different in their geometric relationship at birth and following palatal molding, thereby requiring different modes of treatment to align the palatal arch. (Details of the cast tracings are described in legend 11.)

to be placed in contact. In these cases, the posterior palate is unaffected by presurgical orthopedics and is usually in a class I or class II occlusion and never in a class III occlusion at 6 years of age.

Anterior dental crossbite correction in presurgical orthopedics–treated complete unilateral or bilateral cleft requires the advancement of the premaxilla in bilateral cleft cases or of the premaxillary part of the noncleft segment in unilateral cleft cases. In bilateral cleft presurgical orthopedics cases, as a result of the early palatal manipulation and periosteoplasty over the closed cleft lateral incisor spaces, the premaxillary segment cannot accommodate the impacted lateral incisor, if present (Figs. 11 through 13). This space cannot be regained in the mixed dentition, and in the permanent dentition, it can be regained only after extensive use of orthodontic appliances in 50 percent of the cases.

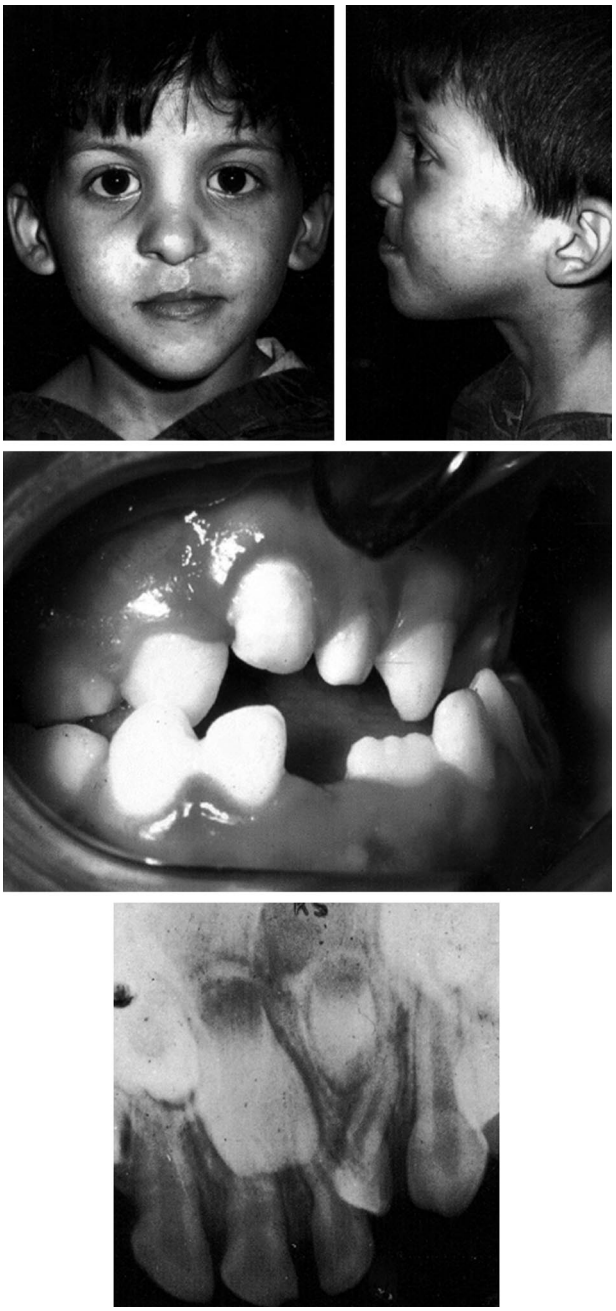

FIG. 14. Eight-year-old boy with presurgical orthopedics–treated complete unilateral cleft lip and palate. (*Above*) Facial photographs show midfacial recessiveness caused by retruding the premaxillary portion of the larger segment. In some cases, the resulting anterior crossbite is correctable in the permanent dentition only after extensive use of orthodontic appliances and only if minor bone bridging occurred. (*Center*) Intraoral photograph shows that the right maxillary lateral incisor space was completely blocked out. The resulting anterior crossbite with an open bite could not be orthodontically corrected in the deciduous dentition. (*Below*) Periapical radiograph shows the blocked-out right lateral incisor space.

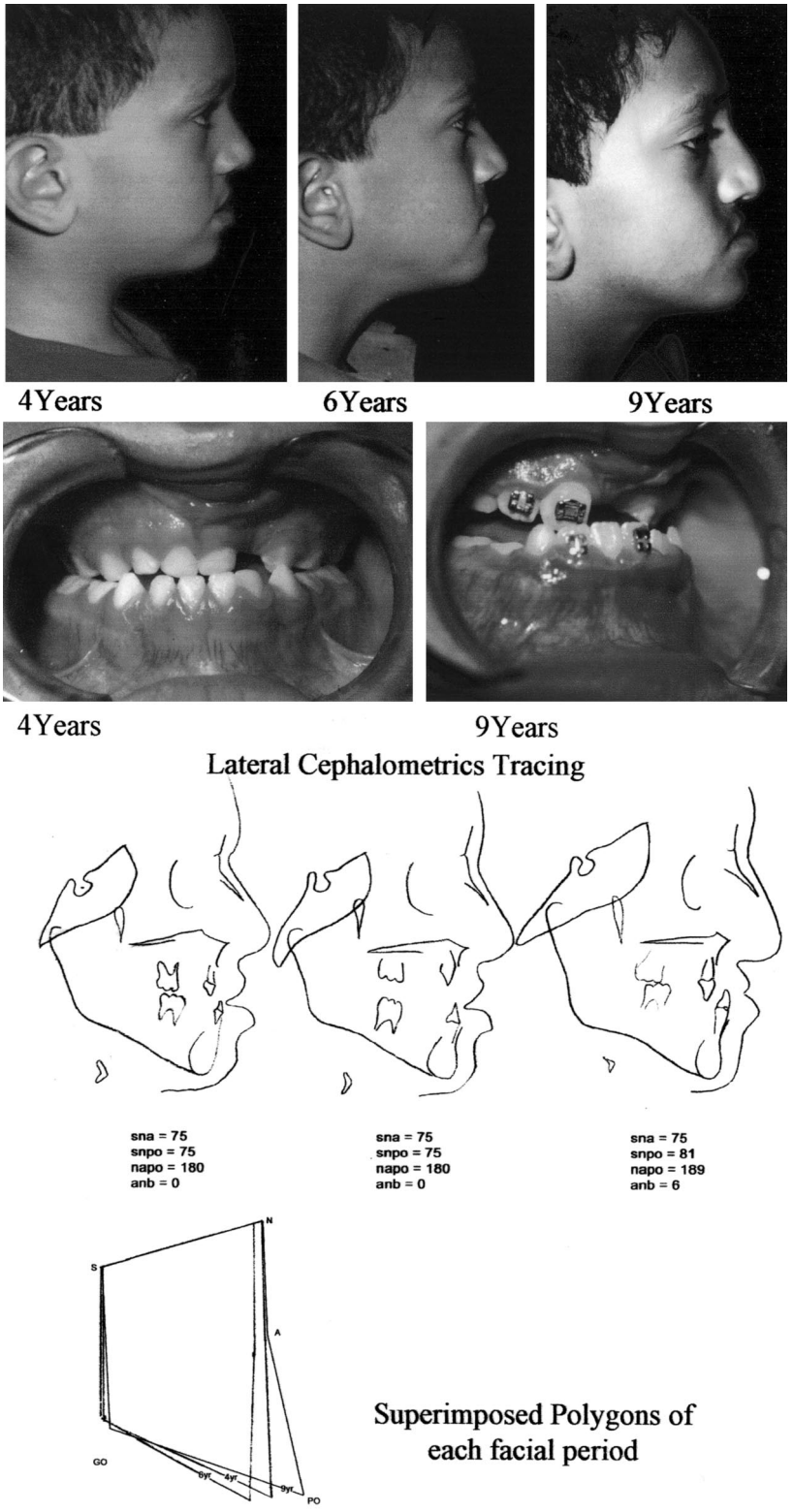

FIG. 15. Photographs of a unilateral cleft patient treated with presurgical orthopedics show the midfacial recessiveness with anterior crossbite worsening with time. (*Above*) Views of the patient in profile show a recessive midface at 4, 6, and 9 years of age. (*Center*) Intraoral occlusal photographs show the anterior dental crossbites at 4 and 9 years of age. (*Below*) Lateral cephalometric tracings show that the midfacial recessiveness worsened with facial growth. Superimposed cephalometric polygons show the unpredictable mandibular growth that makes the midface more recessive.

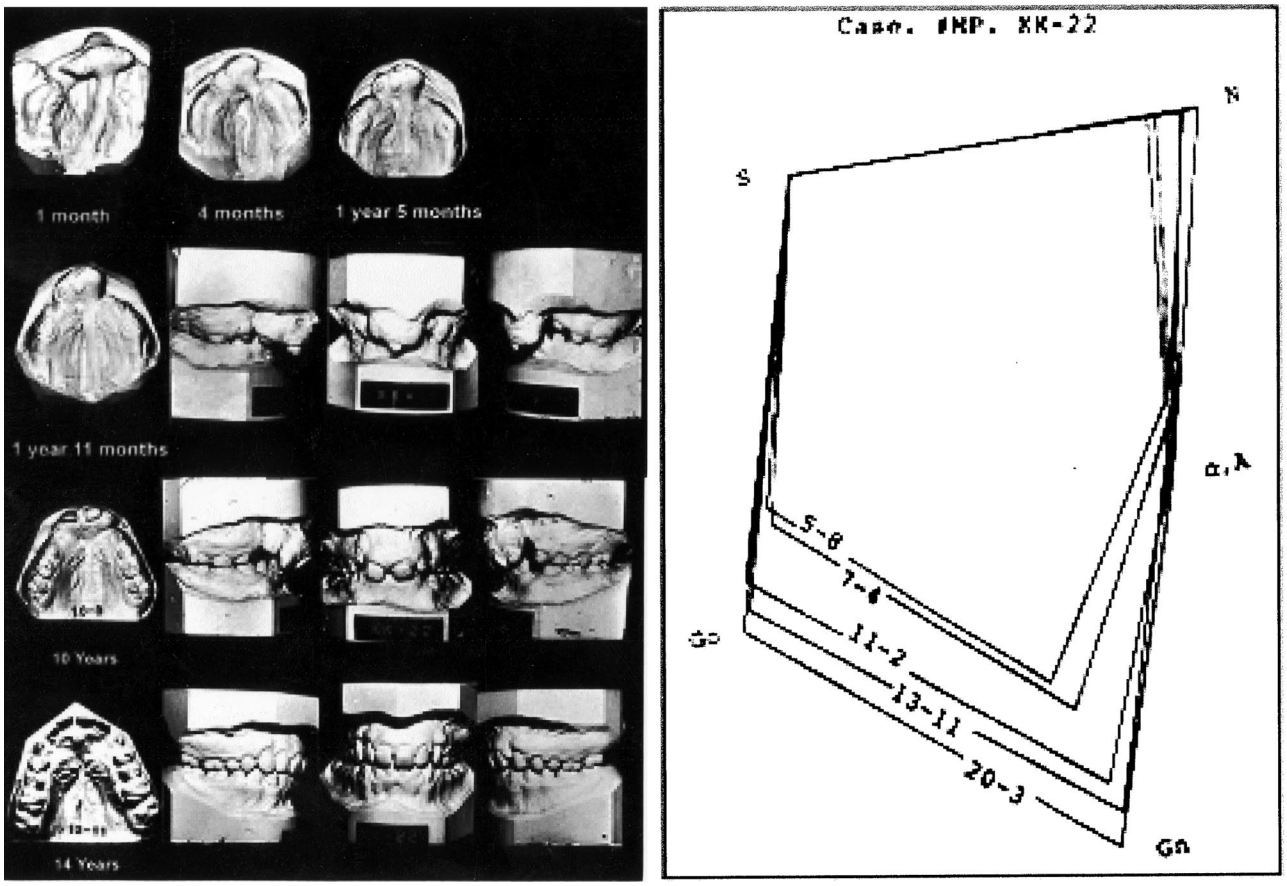

FIG. 16. Conservatively treated (nonpresurgical orthopedics) complete bilateral cleft lip and palate. (*Left*) Serial casts taken from birth to 13 years of age show that initial molding of the palatal segments at 1 year 5 months, with the premaxilla forward of the lateral palatal segments, created a severe overjet and overbite. However, with orthodontic widening of the palatal arch at 5 to 6 years of age, the premaxilla was easily incorporated within the alveolar arch. The palatal cleft is usually closed between 18 and 24 months in these cases. Secondary alveolar bone graphs were placed at 8 years of age, permitting the lateral incisors to erupt into place. (*Right*) Superimposed lateral cephalometric tracing polygons show the gradual reduction of the convex facial profile. The united lip creates a force that ventroflexes the premaxilla. Midfacial forward growth is retarded, while the upper face and the lower face grow forward, flattening the facial profile.

Conservative, Nonpresurgical Orthopedics in Complete Unilateral and Bilateral Cleft Lip and Palate Cases

In nonpresurgical orthopedics–treated bilateral cleft cases, the protruding premaxilla's overjet is gradually reduced so that it can be easily aligned within the alveolar arch by 7 to 8 years of age (Figs. 10, 16, and 17 and Tables I and II). In some patients, this may spontaneously occur after only 2 to 3 months of simple palatal expansion. However, depending on the facial growth pattern, some maxillary dental overjet with a convex facial profile may still remain into the mixed dentition stage. In our study, only two patients with a severely protruding premaxilla at birth developed a retrusive class III malocclusion requiring surgical maxillary Le Fort I advancement. This need was mainly due to reduced maxillary growth coupled with a forward-growing mandible. The use of a protraction facial mask in both cases was unsuccessful in correcting the midfacial recessiveness.

With nonpresurgical orthopedics treatments, there were successful secondary alveolar bone grafts in 70 percent of the patients. In most of these cases, the impacted lateral incisor erupted into its normal position within the alveolus, or if absent, the space was left open for a replacement tooth. If one or both lateral palatal segments are in a class II relationship and one or both lateral incisors are absent, the cuspid(s) can be substituted for the missing lateral incisor(s). In these patients, the maxillary and mandibular anterior arch forms are congruent at the completion of orthodontic treatment. Anterior arch congruency cannot exist in presurgical orthopedics cases without

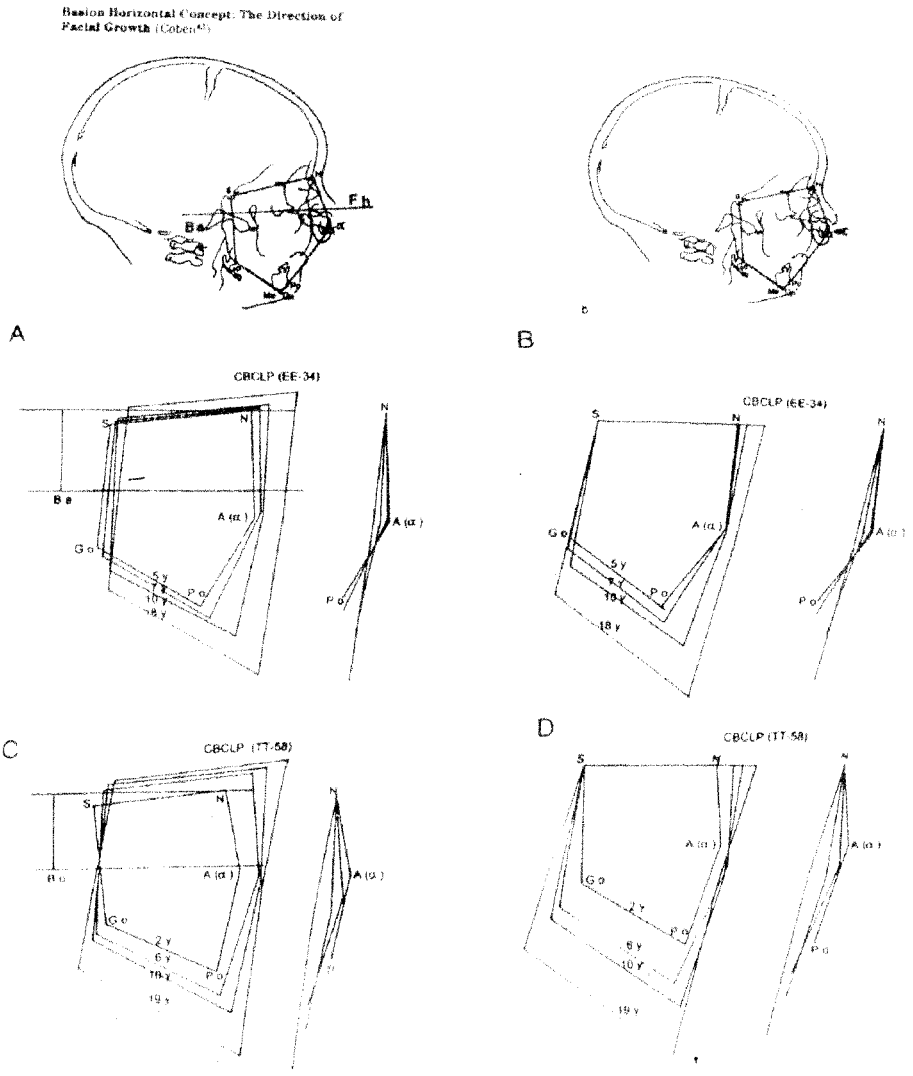

FIG. 17. A number of conservatively treated (nonpresurgical orthopedics) bilateral cleft patients have relatively convex facial profiles that gradually flatten with growth.

extensive use of orthodontic appliances and surgery.

Flattening of the facial profile, contributing to improved facial aesthetics, occurs gradually as the upper and lower portions of the face grow forward while the midface's forward growth is restrained by the forces created by the united lip (Fig. 16). Most significantly, after 2 years of age, three-dimensional measurements show that the premaxilla is in the same ideal position within the maxillary arch, its forward growth having been retarded by the intact lip musculature forces.

Poor facial growth occurs either when the mandible's growth is vertically directed or when the midface fails to grow in concert with the mandible. Either of these variables can occur in both nonpresurgical and presurgical orthopedics–treated cases; they are not under the surgeon's control, and are unpredictable at birth.

The growth analysis of these complete bilateral cleft lip and palate cases demonstrates that increases in anteroposterior maxillary arch length, between the incisal papilla and the first permanent molars, are dependent on the functional integrity of the premaxillary vomerine suture. Once premaxillary vomerine suture function is diminished by excessive forces, growth recovery will not return.

Establishing lip muscle continuity soon after birth causes slow molding of the overexpanded lateral palatal and premaxillary segments, leading to narrowing of the anterior and posterior palatal cleft spaces. In nonpresurgical orthopedics–treated bilateral cleft cases, the posteriorly

TABLE II

Obtained Significant Chi-Square Values ($p < 0.05$) in Tests of Differences in Number of Patients Having Crossbites between Presurgical and Nonpresurgical Orthopedics Treatments*

	Approximate Age of Participant				
	3 Years	6 Years	9 Years	12 Years	Total Sample
Unilateral cleft					
Anterior crossbite	16.8†	30.0†	10.2†	ns	77.5†
Buccal crossbite	30.9†	6.5‡	6.5‡	4.8§	42.8†
Bilateral cleft					
Anterior crossbite	10.3†	11.5†	24.5†	8.6†	35.5†
Buccal crossbite	ns	ns	6.9‖	ns	ns

ns, not significant.

* Data are for the obtained chi-square values in the 16 two-by-two chi-square tests of the treatment differences in crossbite frequency. In 12 of 16 presurgical versus nonpresurgical orthopedics comparisons, a significantly greater frequency of crossbite cases occurred after presurgical as compared with nonpresurgical orthopedics treatment. With but two exceptions (at the 3- and 12-year-old levels for those having unilateral clefts), the chi-square values were greater for anterior crossbite than for buccal crossbite, suggesting that the presurgical orthopedics procedure, relative to the nonpresurgical orthopedics method, was more likely to have an adverse effect on the former than latter type of defect. Except for the 9-year-old subsample, for those born with a bilateral cleft, the presurgical versus nonpresurgical orthopedics differences in crossbite frequency were statistically significant for those with an anterior crossbite but not for the children with a buccal crossbite.

† $p < 0.005$.

‡ $p < 0.025$.

§ $p < 0.05$.

‖ $p < 0.01$.

directed pressure of the elastic strip appears to be within physiological limits, and in most cases the slight pressure created permits additional premaxillary vomerine suture growth. This is seen in the graphic analysis of superimposed serial lateral cephaloradiographs and electronically produced three-dimensional tracings of palatal dental casts (Figs. 11, 12, and 16).

In nonpresurgical orthopedics–treated complete bilateral cleft lip and palate cases, the anteroposterior palatal dimension is greater between birth and 6 years; in contrast, with presurgical orthopedics–treated bilateral cleft cases, once the premaxilla is set back, there is no further change in the anteroposterior first molar–to–incisor dimension due to pressure-caused hemorrhaging at the premaxillary vomerine suture leading to fibrosis and then synostosis. Most of the alveolar cleft spaces are obliterated with new bone uniting the repositioned palatal segments.

In the nonpresurgical complete unilateral cleft lip and palate cases studied, only 16 percent (eight of 51) were in anterior crossbite at 3 years of age, a condition that is easily corrected by advancing the premaxillary portion of the noncleft larger segment. Sixty percent of the presurgical orthopedics cases were anterior crossbites at 3 years (Fig. 9, *above*).

Buccal crossbites in both the nonpresurgical and the presurgical orthopedics treatment series were easily corrected, since the type of palatal procedure performed between 18 and 36 months did not inhibit palatal expansion. Only three of 51 cases (6 percent) had a complete buccal crossbite at 3 years of age (Table I and Fig. 9, *below*). The relative increase in percentage of buccal crossbites in presurgical orthopedics cases at 3 years is significant (60 percent at 3 years), because it necessitated more crossbite corrective procedures at 5 to 6 years of age (Table II and Fig. 9, *below*).

Variations in palatal osteogenic deficiency and its influences on surgical treatment. The location of palatal bone deficiency is highly variable and it can exist to various degrees. In complete bilateral cleft lip and palate, the extent of osteogenic deficiency in the anterior part of the palate can vary in size and shape. In a few of these instances, the palatal cleft space is usually present immediately posterior to the premaxilla, even when the incisors are in a good or poor overbite/overjet relationship. In conservatively treated cases, if this large cleft space is present with the incisors in good overbite/overjet, further surgical treatment needs to be evaluated in the mixed dentition stage or at early adolescence. When there is insufficient mucoperiosteal tissue to surgically close this palatal cleft space, successful secondary alveolar bone grafting will not be possible. In these instances, the only solution is for the posterior palatal segments to be advanced to reduce the cleft space to usable dimensions, followed immediately by secondary alveolar bone grafting.[29] In our study, this operation was necessary in only two of 20 nonpresurgical orthopedics cases; both cases were treated successfully by Dr. Wolfe using the Posnick procedure.

Should this same form of skeletal palatal deficiency exist in presurgical orthopedics–treated cases, the premaxilla would be severely retruded, so much so that one or both lateral incisor cleft spaces would be closed and ultimately bridged by bone, thus preventing the orthodontic-orthopedic correction of the anterior crossbite. The lack of subsequent anterior maxillary and mandibular arch congruency would prevent the achievement of a good dental overbite/overjet relationship, even after midfacial surgical advancement (Figs. 3 and 4).

Correction of midfacial deficiencies in conservatively treated (nonpresurgical orthopedics) cases. A slight anterior crossbite can be easily corrected orthodontically by using the maxillary protraction mechanics of a facial mask, with or without the extraction of one mandibular central incisor. In the nonpresurgical orthopedics-treated complete bilateral cleft lip and palate cases, it was necessary to surgically advance a retrusive midface in only two patients. A well-developed, relatively protrusive mandible existed in only one of these children. Fortunately, no long-term speech changes resulted after maxillary advancement in these two instances. Lateral cephalometrics showed good velar length and elevation within a pharyngeal space of average depth. Intraoral examination showed good lateral pharyngeal wall movement as well.

Similar presurgical orthopedics as it was utilized in the past: it failed then as it does now. During the 1920s and 1930s, the cleft surgeon's treatment philosophy, exemplified by Brophy,[30] was to repair the cleft defect by establishing "normal" anatomical palatal form soon after birth, through the use of external and internal palatal compression techniques. The first priority then was to improve facial aesthetics, followed in turn by good dental function and speech. Unfortunately, the Brophy procedure led to extensive midfacial deformity and was eventually discontinued.

Due to the benefit of long-term facial and palatal growth records, many if not most surgeons and speech-language pathologists have recognized the extent to which time or, more precisely, growth serves as their ally or enemy. However, some surgeons are still endeavoring to devise a procedure that can be used during the first 2 years for all complete bilateral and unilateral cleft lip and palate cases, with the hope that good facial growth will follow.

In recent years, serial documentation of the natural evolution of postnatal facial and palatal development of children with complete bilateral and unilateral cleft lip and palate has yielded important objective data that help explain the dynamics of facial skeleton and palate growth under the influence of various surgical procedures. This knowledge has greatly improved the ability of surgeons and orthodontists to develop physiologically based concepts that lead to successful long-term treatment outcomes.

This study supports Gillies's belief that time is both the surgeon's ally and most trenchant critic. It further supports the thesis that no single surgical procedure performed at birth is suitable for all cleft types and faces, since there is great variation in palatal osteogenesis and in facial growth patterns. Staged treatment based on the individual patient's facial assets and deficits must be the controlling factor in designing therapy.

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