Orthopedic Expansion and Protraction of the Maxilla in Cleft Palate Patients—A New Treatment Rationale

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This preliminary report presents a treatment rationale for cleft lip and palate patients who display underdevelopment of the midfacial complex in the deciduous dentition. In order to create more favorable conditions for midfacial growth, transverse expansion followed by anterior orthopedic traction of the maxillary complex is performed in the deciduous dentition, applying principles introduced by Delaire. A clinical procedure, based on fixed appliances and compatible with edgewise technique has been developed. A treated patient with indicator implants is presented.

KEY WORDS: Orthodontic treatment, orthopedic treatment, maxillary protraction

Irrespective of treatment rationale, a certain number of patients with unilateral complete cleft of the lip and palate reveal an unfavorable growth pattern of the craniofacial complex. The general tendency in complete unilateral clefting is for underdevelopment or posterior positioning of the maxilla and mandible relative to the anterior cranial base, increased steepness of the mandibular plane, a more obtuse gonial angle and other differences (Dahl, 1970; Chierici et al., 1973). There is also shortening of maxillary length relative to the cranial base and maxillary height relative to the anterior facial height (Lande, 1970; Ross, 1970; Chierici et al., 1973; Hotz and Gnoinski, 1976; Bishara et al., 1979; Sirinavin, 1980). These factors may lead to a sagittal discrepancy between the upper and lower jaw, with the maxilla in a relatively more retruded position. If these differences are severe, the transverse width and the anteroposterior length of the maxillary dento-alveolar arch are usually reduced. Antero-posterior growth, however, is the major problem.

It seems essential for the growth of the maxilla and the dentoalveolar arch that the surgical closure of the lip secures good function by rehabilitation of the insertion of the nasolabiogenal muscles at the level of the anterior nasal spine (Delaire, 1978) and that the surgical procedures do not interfere with growth. Hard palate surgery with denudation of bone has been thought to restrain maxillary sagittal and vertical growth due to a continuation of scar tissue in the palate (Ross, 1970; Hotz and Gnoinski, 1976; Jonsson, 1979).

Although the frequency and degree of growth disturbances have been greatly reduced after the introduction of new treatment procedures, individual cases still reveal some maxillary collapse in antero-posterior, vertical and transverse directions, even at four to six years of age. This is manifested by partial or complete anterior or posterior crossbite (Pruzandky and Aduss, 1967; Bergland and Sidhu, 1974; Hotz and Gnoinski, 1976; Dahl and Hanusardottir, 1979; Sirinavin, 1980).

The aim of this presentation is: 1) to discuss the timing of orthopedic-orthodontic treatment of cleft palate patients having underdevelopment of the maxilla with partial or complete anterior or posterior crossbite in the deciduous dentition; 2) to present a treatment

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rationale and the design of a fixed appliance system that can be used for both transverse expansion and protraction of the maxilla and 3) to present a case where this system was used.

New Treatment Methods

The introduction of the facial mask for early protraction by heavy forces to the maxillary complex in cleft lip and palate patients by Delaire et al. (1972, 1976) created new possibilities for influencing not only the dentoalveolar system but the more basal parts as well. Compared to earlier attempts, where anteriorly directed extra-oral forces were derived from chin-cup arrangements (Kettle and Burnapp, 1955), this new method seemed to offer a wider range and better control of force application, particularly in the vertical direction.

Conventional correction of the maxilla is mainly rotation and expansion of the lateral segments with some lateral movement of the maxillary bones and labial tipping of lingually positioned upper incisor teeth. It is undertaken by removable or fixed appliances, sometimes combined with intermaxillary elastics. These methods fail to yield any appreciable forward movement of the maxillary dentoalveolar arch and none of basal parts. Intermaxillary elastics can be used only to a limited extent without unduly taxing the mandibular dental arch, and using the posterior maxillary segments as anchorage against forward expansion of the anterior parts of the arch often worsens the basal maxillo-mandibular discrepancy. An insecure intercuspidation and edge-to-edge incisor relationship is often the result.

Extraoral forces from a facial mask can be directed forward and downward to the maxillary cuspid area of the alveolar process which frequently reveal an inadequate vertical development. In this way a deep and securely locked intercuspidation between upper and lower cuspids is obtained. Use of a facial mask also permits the establishment of good vertical closure of the incisors after correction of an anterior cross-bite. This is particularly important for the transmission of functional stimuli to the maxilla and thereby increasing stability. Previous authors who found little lasting effect from orthodontic treatment in the deciduous and early transitional dentition, have not reported use of this kind of extraoral forward and downward traction (Ross and Johnston, 1972; Bergland and Sidhu, 1974; Hotz and Gnoinski, 1976). Neither did advocates of orthodontic treatment during the deciduous dentition (Rosenstein, 1960; Hellquist, 1970).

Effect of oro-facial dysfunction on the growth pattern.

The tendency to attenuated growth and retropositioning of the mid-face and a long anterior lower face is aggravated by disturbance of nasal respiration, low and forward posture of the tongue complex and lack of correct stimuli from proper mastication. Patients with difficulties in nasal breathing reveal increased lower and total anterior facial height, reduced sagittal depth of the bony nasopharynx, lower tongue position and a more extended posture of the head which in turn influences the position of the mandible (Subtelny, 1954; Holik, 1957; Ricketts, 1958; Bushey, 1960; Linder-Aronson, 1970; Yip and Cleall, 1971; Linder-Aronson, 1979). A switch from mouth to nose breathing following adenoidectomy leads to a more anteriorly directed growth pattern of the mandible (Linder-Aronson, 1975). Since there is a direct relationship between growth pattern and type of respiration, an attempt to earlier normalization of the respiratory function in cleft palate patients seems clearly indicated.

Nasal airway resistance to breathing is higher among individuals with clefts than in normals. This has been attributed to nasal deformities and maxillary growth deficits, both of which tend to reduce the size of the nasal airspace (Drettner, 1960; Warren et al., 1969). In cleft palate patients reduced nasal respiratory function has been found to contribute to the increased anterior facial height (Delaire, 1976; Linder-Aronson, 1979).

Orthopedic expansion of the median palatine suture in non-cleft mouthbreathers lowers the nasal breathing resistance to normal values and thus enhances nasal respiration (Linder-Aronson and Aschan, 1963; Herschey et al., 1976; Loreille and Bery, 1981). There is clinical evidence that lateral expansion of the maxilla enhances increased nasal respiration in cleft patients. Protraction of the maxilla increases the vertical height as well as the sagittal length of the maxilla. The influence of protraction on the quality of respiration is presently under investigation.

The experiments carried out by Harvold et al. (1972, 1973) on monkeys in which the tongue was induced to adopt a lower position led to a lowering of the mandible and an increase in the lower anterior facial height. The situation in cleft lip and palate patients with some collapse of the maxillary dental arch is in several respects similar. The repaired palatal vault is lower than in non-cleft children and crossbite of the maxillary segments reduces the space available for the tongue. The vertical, transverse and labial underdevelopment of the alveolar processes in the upper jaw may partly explain the lower tongue position in cleft palate children (Sirinavin, 1980). Low posture of the tongue, due to lack of nasal respiration and to restrained sagittal and vertical growth of the mid-face further favors both mandibular rotation and maxillary retrognathism (Ross, 1970).

Expansion and protraction increase the dimensions of the nasal as well as the oral space, thus permitting a higher position of the tongue. This may break a vicious circle of poor function leading to poor form which further affects function.

The importance of correct function of the primary incisor and cuspid teeth for the development of the anterior part of the maxilla have been clearly shown. Cleft lip and palate patients reveal hypoplasia and underdevelopment of the skeletal force-lines in the anterior part of the face due to lack of expansive impulses from correct occlusal forces (Delaire and Salagnac, 1977; Sirinavin, 1980).

Anterior and posterior crossbite may cause dental interferences which result in a "forced" bite in young cleft patients, as can sometimes be observed by the pattern of attrition of the deciduous incisors. The impulses received by both jaws during mastication and other oral functions are abnormal, and inhibit the sagittal and lateral development of the basal and dento-alveolar parts of the upper jaw.

Reduced treatment potential by postponing treatment.

Collapse of segments of the maxillary dental arch prevents surface growth and thereby prevents segmental growth and arch length increase. Since sutural growth of the upper jaw is very active at 6–7 years of age and then declines until the pubertal spurt (Bjork, 1966), it seems logical to liberate the maxilla and enable growth to take place at this time under the influence of normal impulses from mastication. The early maxillary growth peak may explain the observation that basal maxilla changes are observed mainly with protraction therapy instituted before the age of 8 years in non-cleft patients (Delaire et al., 1976). In cleft lip and palate patients, early protraction treatment has been found to yield far better basal response than late treatment (Delaire et al., 1972; Subtelny, 1980). The age factor may explain why Friede and Lennartson (1980) found favorable effect on only two out of four cleft lip and palate patients treated with protraction since treatment was started between 8 and 13 years of age. By expanding any part of a collapsed maxillary dental arch the normal outwardly directed eruption of the permanent teeth is enhanced. Ample space is created for the teeth in the incisor region, thus aiding eruption.

When periostoplasty has been performed with subsequent bone formation in the alveolar region of the cleft, lateral expansion will influence the median suture in the interincisor area. With no bone in the cleft area, early widening will enhance surface bone deposition in a period of rapid growth.

Treatment time in deciduous dentition.

The orthopedic-orthodontic treatment of a cleft lip and palate patient must be based on short periods of active, controlled, efficient treatment and long periods of effective retention. Our treatment is based on fixed appliances both during treatment and to a large extent during retention. A survey of 40 treated patients with 1–3 years follow-up indicates that total treatment time has not been increased when compared to previous methods.

Treatment rationale

Appliances. Age six years seems the ideal time to begin treatment, since the eruption of the permanent maxillary incisors takes place during the treatment and control period. The appliance was developed to provide controlled expansion, an attachment for anterior traction with the facial mask, compatibility with edgewise appliance therapy, and good hygiene.

A fixed appliance is preferred for segmental expansion without tipping of teeth. An acrylic plate would occupy more space and tend to lower the tongue position which is already low. During protraction a vertical component in the cuspid region is favorable, establishing a good cuspid intercuspatation. A fixed appliance will resist the downward-directed traction (Figure 1).

Transverse expansion.

A modified quad-helix appliance is soldered to bands on the second deciduous molars and deciduous cuspids (Figure 1). The first molar is thus locked and serves as anchorage as well. Maxillary first permanent molars are used only when the second deciduous molars are missing or decayed. There is a hook for attachment to the facial mask mesio-lingually to the cuspid bands. The total expansion period lasts 2–3 months, with 1 or 2 activations at 5–6 weeks' interval. Expansion is completed before protraction begins.

Protraction

The quad-helix is made to contact the incisors (Figure 1 B) or a bar is soldered after expansion (Figure 1 C). Additional labial

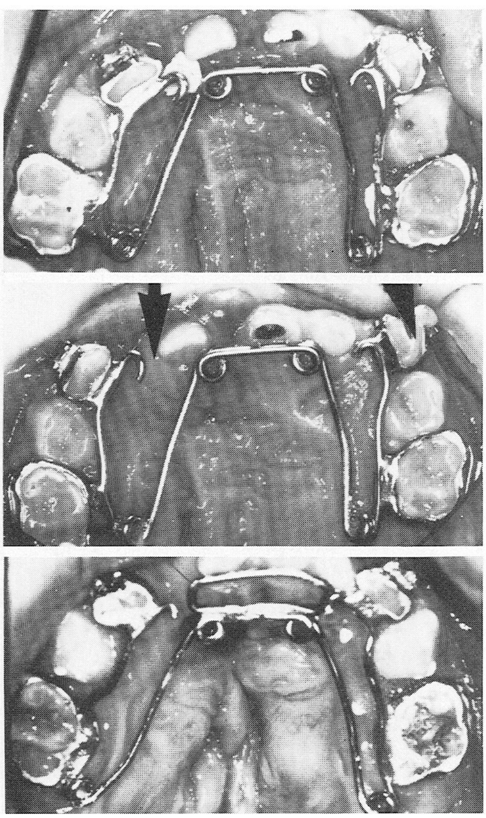

FIGURE 1. Appliance for transversal expansion and protraction. Note hooks mesio-lingual on deciduous cuspids. (A) Before expansion. (B) After expansion. (C) With lingual bar supporting incisors.

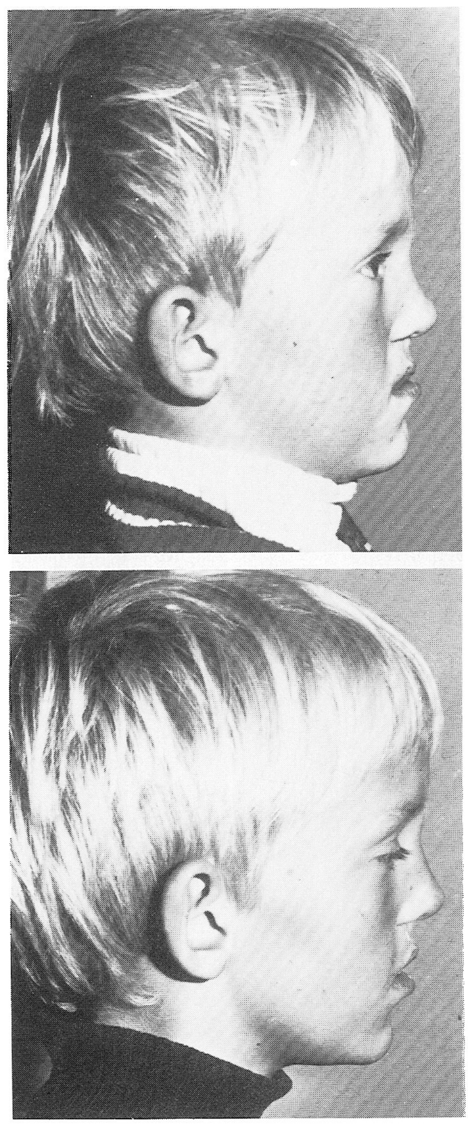

FIGURE 2. Patient F. K. ♂. (A) Before protraction. (B) After protraction (corresponds to Figure 6 A).

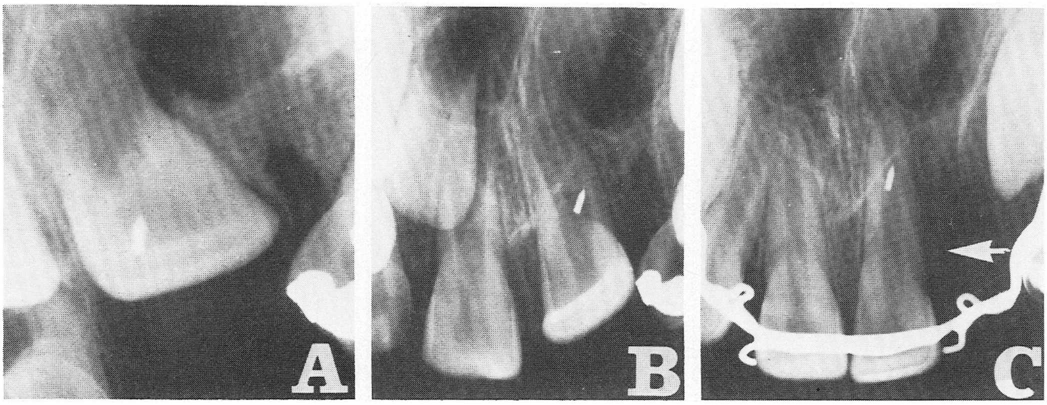

FIGURE 3. Patient F. K. (A) Bone bridge in cleft area with permanent lateral at six years of age. (B) After expansion. (C) After protraction and alignment of incisors. Bone development adjacent to erupted incisor (arrow).

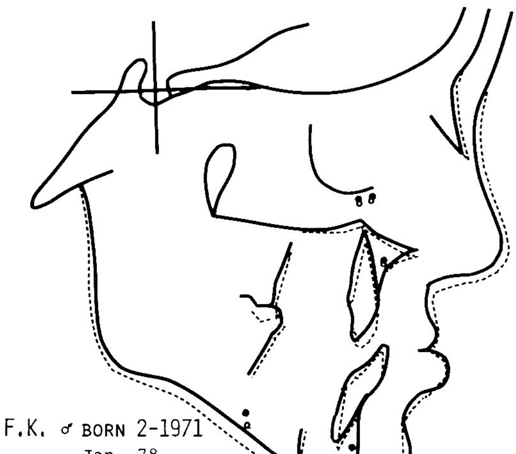

FIGURE 4. Patient F. K. Growth of the upper jaw during eleven months before treatment mainly in vertical direction.

movement of the upper incisors can be obtained by adding a spring. In cases where no transverse expansion is needed, a simple lingual arch is soldered to the second deciduous molars and cuspids, or a conventional labial multiband procedure is used, or both.

In all instances where a downward force component to the maxillary incisor teeth is indicated, these teeth are banded or bonded. In cases where the incisors should be protruded bodily to obtain surface bone deposition in the A-point area, the use of edgewise arch wires is indicated, if necessary with a labial root torque.

Case Report

Male patient F.K. (U-CLP) (Figure 2) had his lip and anterior third of the hard palate surgically closed at 3 months with a periosteoplasty to the alveolus. The palate was repaired at two years using a palatal push-back procedure. Implants were placed at the right and left inferior ridges of the infrazygomatic crest and at the anterior aspect of the maxilla in the subspinal area. At 6 years a bridge of bone had formed over the cleft area on the palatal aspect (Figure 3 A). The patient exhibited a retrognathic face with underdevelopment of the midfacial complex (Figure 4) as well as anterior and left lateral crossbite (Figures 5 A, B, C).

Orthodontic treatment began at 7 years 11 months, about two years later than considered optimal. Three months of maxillary expansion increased arch width between the first deciduous molars by 8 mm. (Figure 5 D) and was followed by protraction using the facial mask for six months (Figure 5 E). The post-treatment observation period was one year (Figure 5 F). Cephalometric radiograms were obtained one year prior to and at the beginning of orthodontic therapy (Figure 4), at the beginning and at the completion of face mask therapy (Figure 6 A) and after one year of passive retention (Figure 6 B). The cephalograms were superimposed on the anterior cranial base with center at sella. It is noteworthy that maxillary and mandibular growth in the ten months before treatment was essentially vertical (Figure 4).

The effects of protraction on the maxillary

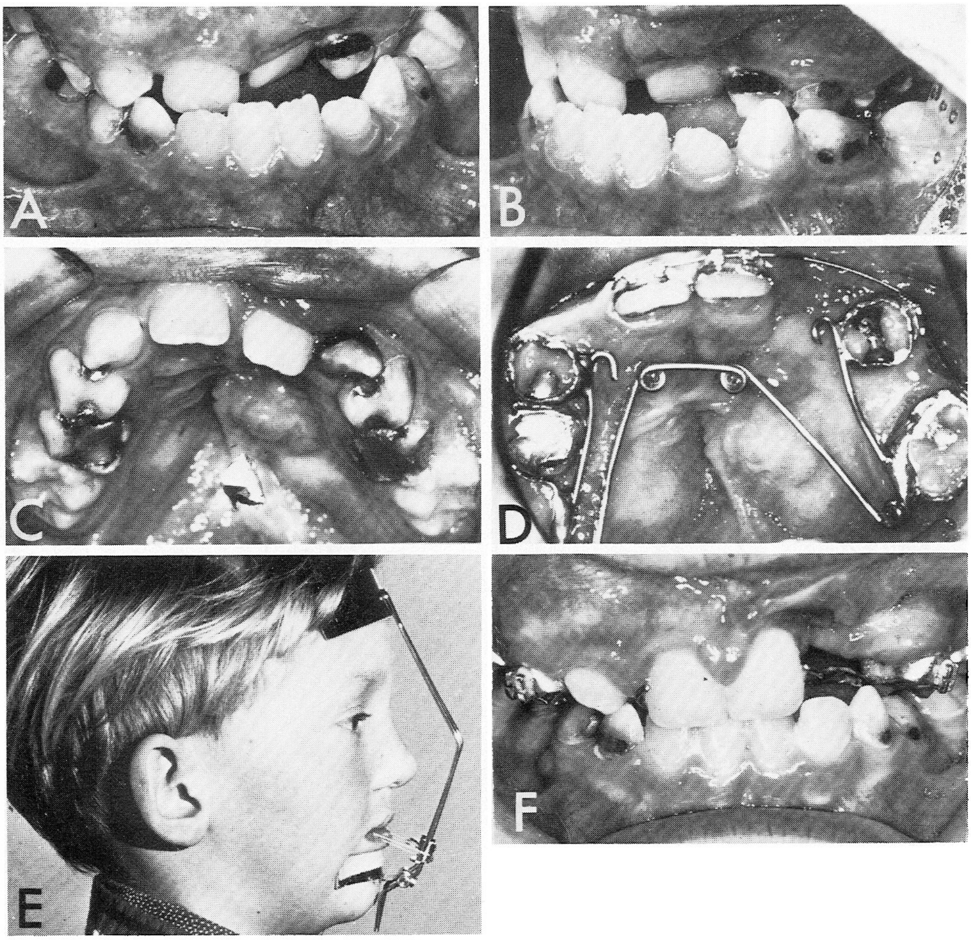

FIGURE 5. Patient F. K. (A, B, C) Anterior and left lateral cross-bite. (D) After expansion and incisor alignment for three months. (E) Protraction. (F) One year after active treatment.

complex was a forward displacement with slight rotation of the basal maxillary complex (Figure 6 A). There was a lowering of the posterior part of the palatal plane, a forward upward advancement of the anterior part of the maxilla including the nasion region. The distance between the maxillary implants placed in the subnasal area is 2 mm. (Figure 6 A). That the implants in the infrazgomatic reveal a corresponding amount of forward displacement indicates that the protraction has had a definite effect on basal parts of the mid-face. There was an increase in the SNA angle of only two degrees, since the nasion has been displaced forward during the protraction. Some dento-alveolar response with mesial movement of molars and extrustion of incisors is revealed by the superpositioning of cephalograms on the maxillary implants (Figure 7 A). A secure vertical overbite has been obtained (Figure 5 F).

The effect of protraction on the lower face was a lowering of the mandible with a posterior rotation (Figure 6 A) and a considerable lingual tipping of the incisors (Figure 8 A). A moderate extrusion of the mandibular teeth has occurred. The only force application in the lower face was pressure on the chin and the alveolar bone in the incisor area from the face mask.

In the one-year post-treatment retention period a fixed lingual arch soldered to bands on the first permanent and deciduous molars and supporting the incisors was worn. No growth change nor relapse of the basal parts of the mid-face was observed (Figure 6 B). A

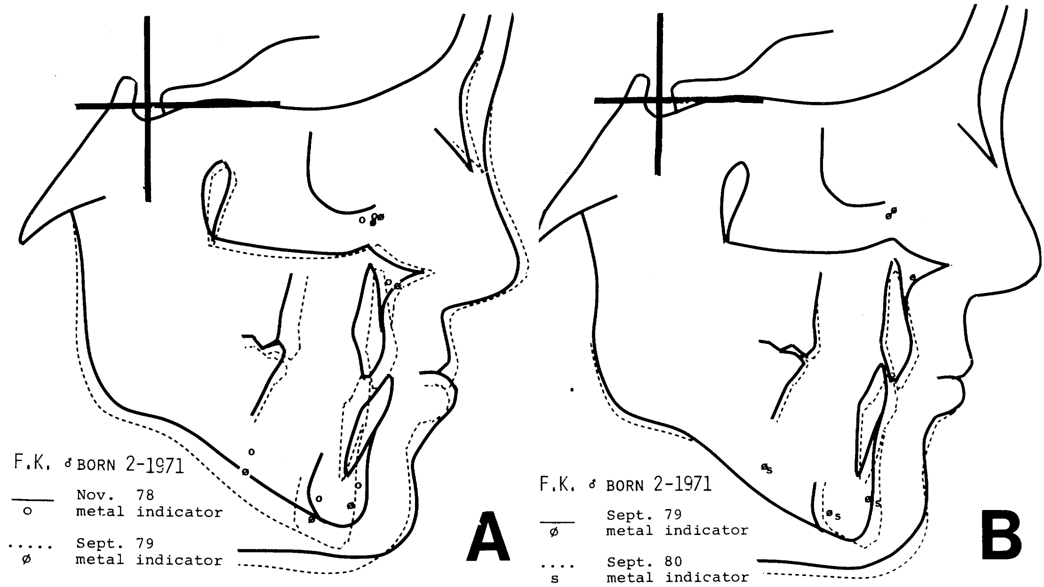

FIGURE 6. Patient F. K. (A) Changes during three months of expansion and eight months of protraction. (B) Changes during one year of passive retention.

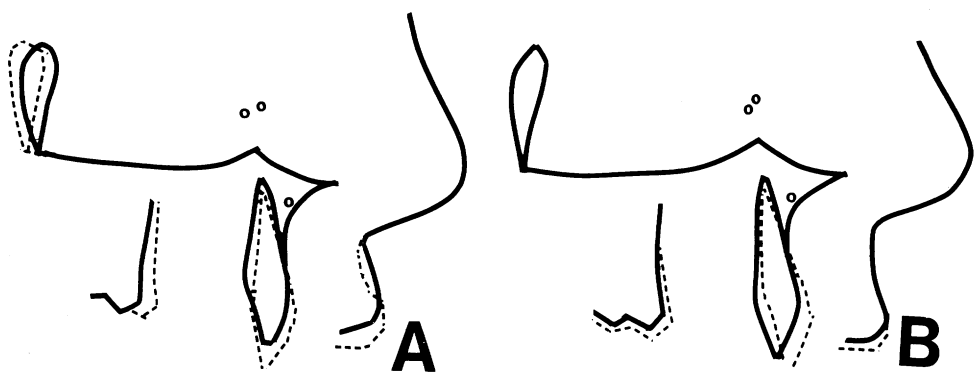

FIGURE 7. Patient F. K. (A) Changes of the maxilla during protraction (cephalograms superpositioned on the implants). (B) Changes of the maxilla during one year in passive retention.

slight mesial movement and eruption of the maxillary molars, and protrusion and eruption of the incisors occurred (Figure 7 B). The mandible resumed an anteriorly directed growth direction with indications of remodelling of the mandibular base. The lingual uprighting of the incisors that had taken place during face-mask treatment remained (Figure 8 B).

During the phase of transverse expansion of the maxilla, the bone bridging the cleft of the alveolar process followed the adjacent central incisor during eruption, thus increasing in volume and density (Figure 3 B). The permanent cuspid has also moved in occlusal direction with a similar effect on the bone in the former cleft. The bone across the cleft seems to have a trabecular system reflecting a stretching influence (Figure 3 C).

This case reveals a detectable orthopedic movement at the basal maxilla in an anterior direction. At The Bergen Cleft Palate Center 44 complete cleft lip and palate patients have been treated according to the described rationale and now have a post-treatment follow-up varying from one to three years. Since the stability of the jaw and facial relationship is largely dependent upon whether the maxilla

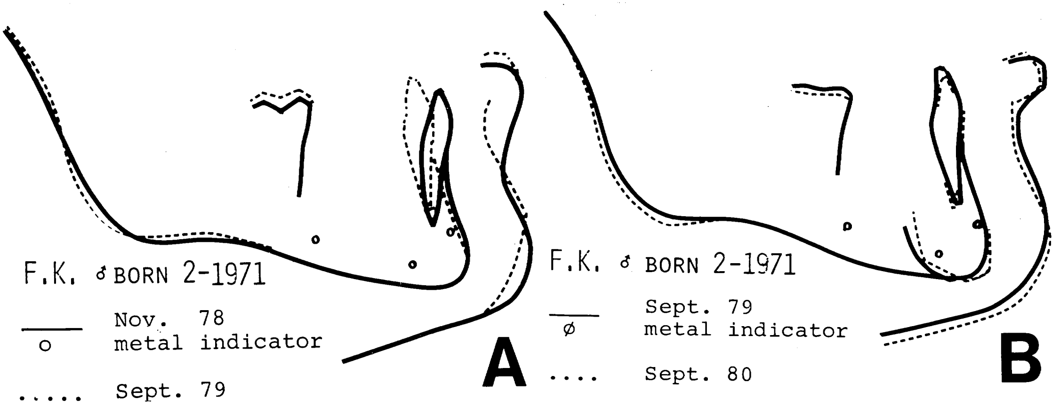

FIGURE 8. (A) Changes in the mandible during face-mask treatment. (B) Changes during one year of passive retention.

will continue to grow, the material will be presented when the two year follow-up data is available.

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