Exploitation of the Residual Premaxillary-Maxillary Suture Site in Maxillary Protraction

An Hypothesis

Bruce S. Haskell

Allan G. Farman

A discussion of the patency of the maxillary-premaxillary suture and its possible value in orthopedic protraction of the premaxillary segment, illustrated by a case report

KEY WORDS: • MALOCCLUSION • CLASS III • PREMAXILLA • SUTURE •

Anatomical texts and recent literature deny the presence of a separate premaxilla in postnatal humans. Nevertheless, portions of a patient's premaxillary-maxillary suture site are described in skulls from individuals well into their first decade of life. Open palatal suture sites can occasionally be seen on occlusal radiographs of orthodontic patients.

It may therefore be hypothesized that suture patency could be an important factor in the successful outcome of nonsurgical maxillary protraction.

Nonsurgical approaches to the treatment of craniofacial anomalies have again become more in vogue with clinicians. An orthopedic protraction technique for the correction of skeletal Class III malocclusions has been of particular interest when the etiology is diagnosed as a deficient maxilla combined with a normal or only slightly prognathic mandible.

Human and experimental animal studies employing cephalometric and histologic descriptions have shown that it is possible to advance the maxilla with appropriate facial traction. Such success is based on the direct stimulation of maxillary suture sites.

While the human studies have demonstrated that it is possible to displace point A (subspinale) from 2.5MM to 5MM anteriorly, the reports are few. The marked variability in treatment success has gone unexplained, except for mention of

Author Address:

Dr. Bruce S. Haskell
Department of Orthodontics
School of Dentistry
Health Sciences Center
University of Louisville
Louisville, KY 40292

Dr. Haskell is Clinical Associate Professor in the Department of Orthodontics at the University of Louisville, Kentucky, and Adjunct Research Associate in Physical Anthropology in the Department of Anthropology at the University of Pittsburgh, Pennsylvania. He is a dental graduate (D.M.D.) of the University of Pittsburgh, and also holds a Certificate in Orthodontics from the Eastman Dental Center in Rochester, N.Y. and a Ph.D. degree in Physical Anthropology from the University of Pittsburgh.

Dr. Farman is Professor and Director of Radiology at the University of Louisville, Kentucky. He is a graduate of the University of Birmingham School of Dentistry in England, with B.D.S, L.D.S.R.C.S, Ph.D., (Odont.), M.I. Biol., Ed.S.

obvious factors such as patient cooperation or the timing of suture closure as related to skeletal maturation (SUBTELNY 1980, IRIE AND NAKAMURA 1975, NANDA AND GOLDIN 1980, AND NANDA 1980).

Literature dealing with orthopedic protraction of the premaxillary segment in noncleft patients is virtually unknown, and there is still controversy over whether a premaxilla *per se* with a patent suture actually exists at any stage of development (RYGH AND TINDLUND 1982, WOOD ET AL. 1967). Such a suture could possibly predispose toward success of any advancement effort.

A recent extremely thorough work by SCHWARTZ (1982) reporting delayed suture site closure in the premaxilla has presents a possible explanation for the variable success or failure of maxillary orthopedic protraction. If a premaxillary-maxillary suture site would remain partially open in cases undergoing active facial protraction, or if such a residual suture can be stimulated to enhance or supplement bone remodeling in the anterior maxilla, it could be of significance in the nonsurgical interceptive treatment of Class III malocclusions.

Anatomy texts and clinical literature still indicate that no suture exists in the premaxillary-maxillary region in man after three months of intrauterine development (NOBACK AND MOSS 1953, AND HOLLINSHEAD 1974).

A number of papers have claimed from one to three separate centers of ossification bilaterally in this region, while others were unable to satisfactorily demonstrate the existence of any separate ossification center (WOO 1949, AND WOOD ET AL. 1969).

In contradiction to this literature, SCHWARTZ (1982) reported the existence of residual patency in the premaxillary-maxillary suture site in the archaeological remains of perinatal individuals from the 7th to 4th centuries B.C. in Punic Carthage.

ANDERSON AND MATTIESSEN (1967) illustrated that the infraorbital foramen corresponds to the embryonic maxillary isthmus which marks the boundary between the embryonic premaxilla and the actual maxillary bone. Schwartz's examination of skeletal materials demonstrated a portion of the suture remaining patent medial to the infraorbital foramen until four years of age.

Perhaps the most comprehensive examination of this subject was by ASHLEY-MONTAGUE IN 1936. He reviewed thousands of human specimens of many races, as well as nonhuman primates, and reported that the human premaxillary segment is still apparent after three months of age.

He concluded that the anterior plates of the human maxilla overgrow and obliterate external evidence of a gross suture on the facial surface, while a residual sutural separation remains between the premaxilla and maxilla in the vicinity of the apical portion of the premaxilla until the fifth year.

The premaxillary suture was distinctly observed on the palatal surface in most infant skulls and in 26% of all crania above the age of six years.

Racial polymorphism seems to be an important factor in the degree of premaxillary separateness. WOOD-JONES (1925) stated that the prognathous races exhibit a later closure of the palatal suture site. Residual suture patency was also observed with greater frequency in Blacks, Australian Aborigines, New Caledonians and in Eskimos. MOSHER (1909) observed larger premaxillary segments in Blacks than in Caucasians, concluding further that alveolar and dental procumbency in the latter is due to this finding.

SICHER (1965) has stated that the most important growth sites for the development of the maxilla include the frontomaxillary, zygomaticotemporal, the zygomaticomaxillary and the pterygopa-

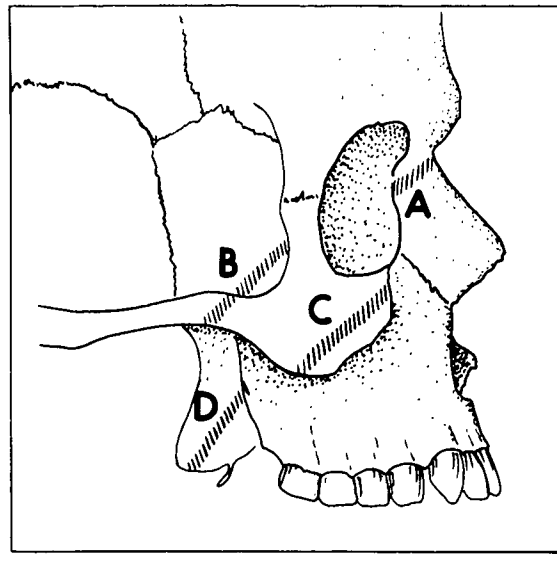

Fig. 1 The orientation of sutures responsible for downward and forward growth of the face (After Sicher, 1964).

latine sutures (Fig. 1). Sicher noted that these sutures are parallel to each other and oriented from above and anteriorly to downward and posteriorly. Growth at these sites has the effect of shifting the maxillary complex downward and anteriorly. It is likely that success in facial protraction orthopedics results from favorable suture orientation to the direction of pull and to suture patency.

Persistence of the suture patency has been documented in even older children. The presence of an open suture in a skull of a six-year-old in the Department of Radiology Clinic collection at the University of Louisville School of Dentistry is illustrated and can be compared with the absence of this suture in an adult specimen (Fig. 2). In addition, the presence of a patent premaxillary-maxillary suture has been an occasional chance finding on occlusal radiographs of patients in their first decade (Fig. 3).

The relevance of the above may not lie in whether human populations actually possess an independent premaxilla perinatally. The more pertinent question is whether clinicians can feasibly exploit this homologue of the nonhuman premaxillary bone as part of a corrective treatment.

This paper reports successful nonsurgical maxillary protraction in a nine-year-old. The possibility of an open premaxillary-maxillary suture site (incisive suture) enhancing this form of therapy is discussed in relation to its possible value as a predictor of treatment success.

Case Report —

This nine-year-old Caucasian girl presented with a Class III malocclusion with a complete anterior crossbite (Fig. 4). It was not possible to shift the mandible to a more retruded position, as centric rela-

Fig. 2 Presence and absence of the premaxillary-maxillary suture in juvenile and adult specimens.

Fig. 3 Evidence of the residual premaxillary-maxillary suture in an eight-year-old Caucasian female.

tion and centric occlusion were nearly identical.

Intraoral radiographs revealed a normally-developing complement of permanent teeth. The facial profile was flat (Fig. 5). Cephalometric evaluation showed a very concave skeletal profile with typical Class III characteristics. The maxilla was retruded (S-N-A 77°), and the mandible protrusive (S-N-B 81°) (Fig. 6).

Treatment Plan

It was decided to attempt to correct the maxillary deficiency as well as the crossbite. A long-term growth forecast accomplished with the technique developed by RICKETTS (1975) indicated that a 3MM advancement of point A would be needed in order to achieve a normal occlusion and allow for continued mandibular growth.

A removable appliance was fabricated to apply approximately 500gm of elastic traction from a facemask (Fig. 8). The elastic hooks were placed to direct the force closer to the centroid of the maxilla than would be possible with fixed appliances such as employed by DELAIRE ET AL. (1972). This was intended to avoid the rotation of the maxilla and bite opening often associated with protraction.

Fränkel pads were incorporated to reduce the effects of the lip musculature on the advancing maxilla and incisors. Occlusal coverage was incorporated to reduce dental interferences which might inhibit protraction. Finally, expansion screws were placed so as to advance the premaxillary segment from the maxillary segment.

The patient was instructed to wear the appliance 14 hours daily. This treatment was continued for nine months.

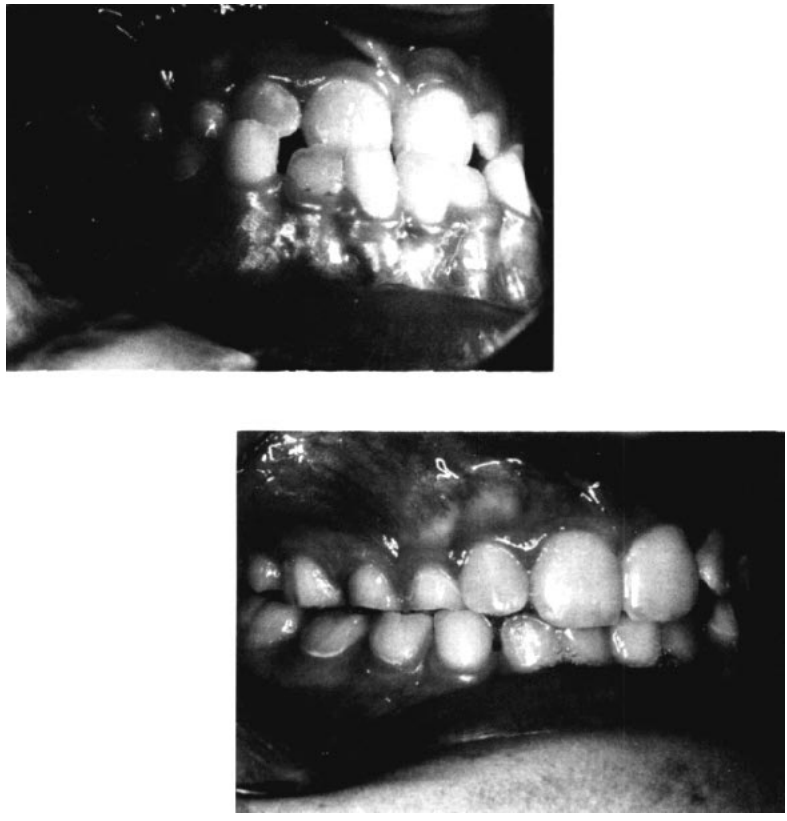

Fig. 4 Anterior crossbite in the reported case before and after correction

Results

After nine months a new cephalometric radiograph showed the maxillary position as determined by S-N-A to have advanced 4° to 81°, while S-N-B increased 2° to 83° (Figs. 6 and 7). Appreciable dental and skeletal changes were accomplished to correct this anterior crossbite with minimal flaring of the maxillary anterior teeth (Fig. 4). A slight posttreatment protrusion of the upper lip is evident (Fig. 5).

DELAIRE (1978) has recently reported a close association of the fibers of the orbicularis oris with those of the anterior nasal spine. The use of Fränkel pads to relieve strain on the associated hard tissue structure while inducing strain on the lip musculature may have aided dental advancement and contributed to the fuller lip contour. This prominence is expected to diminish with further facial development.

Pretreatment

Fig. 5 Pretreatment and posttreatment profiles

Posttreatment

Fig. 5 *Continued*

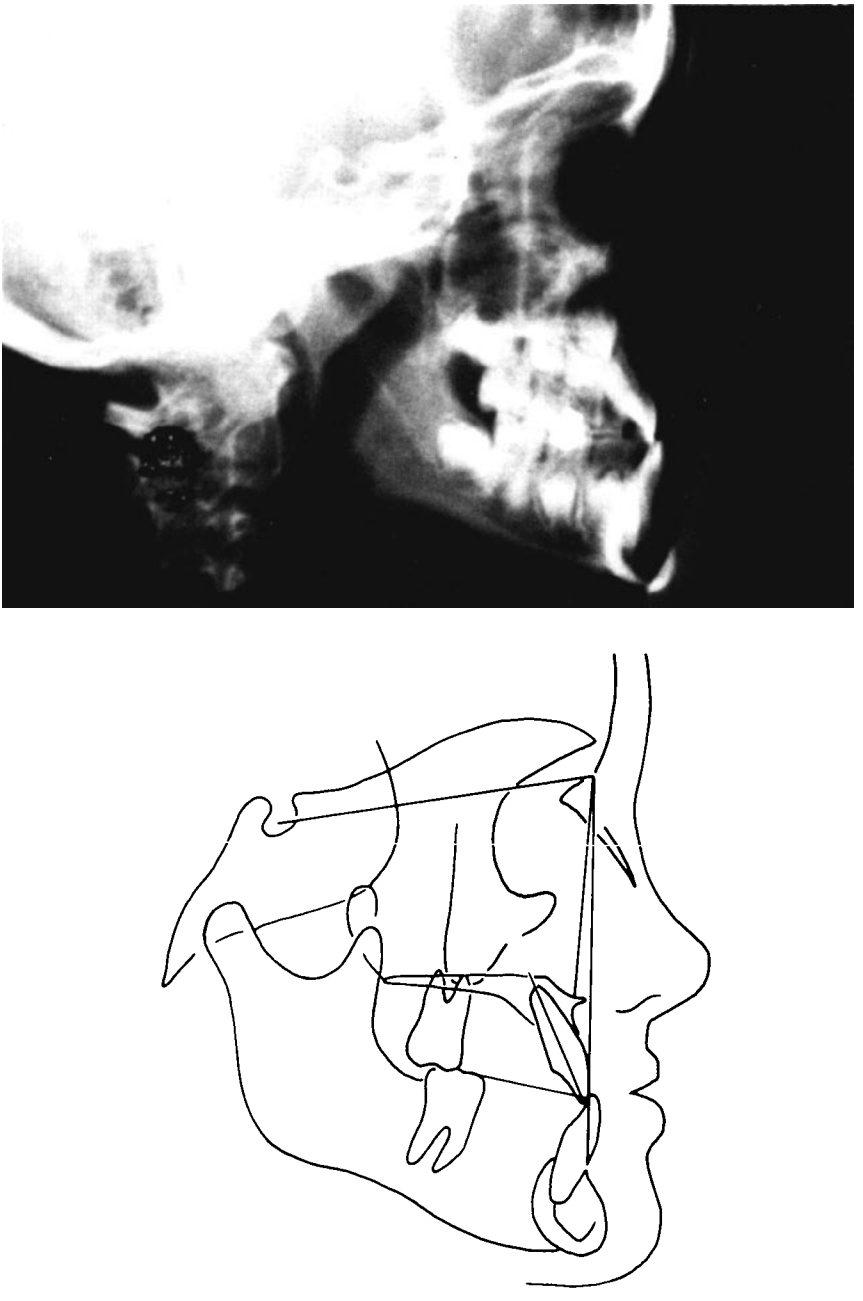

Fig. 6 Pretreatment cephalograph S-N-A 77°, S-N-B 81°

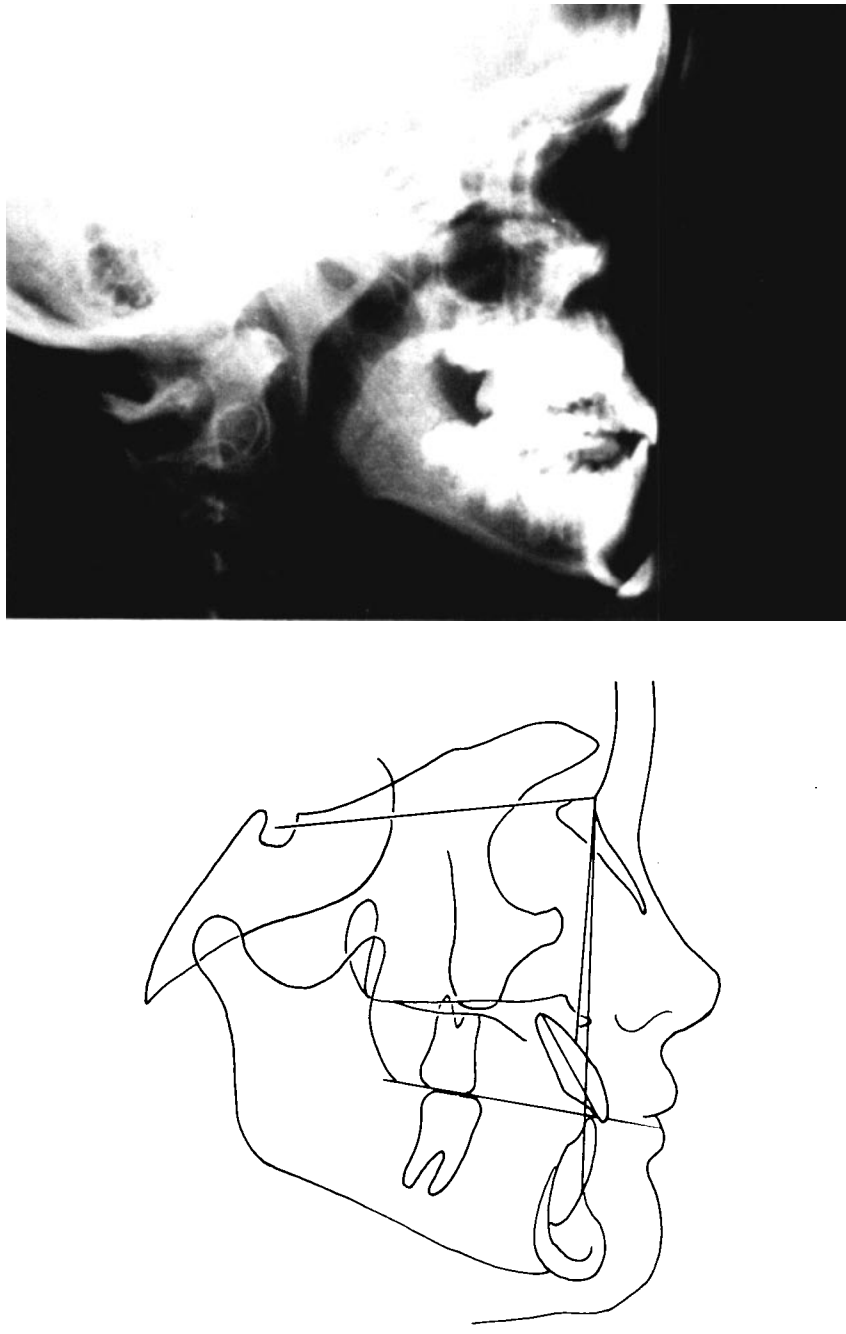

Fig. 7 Posttreatment cephalograph S-N-A 81°, S-N-B 83°

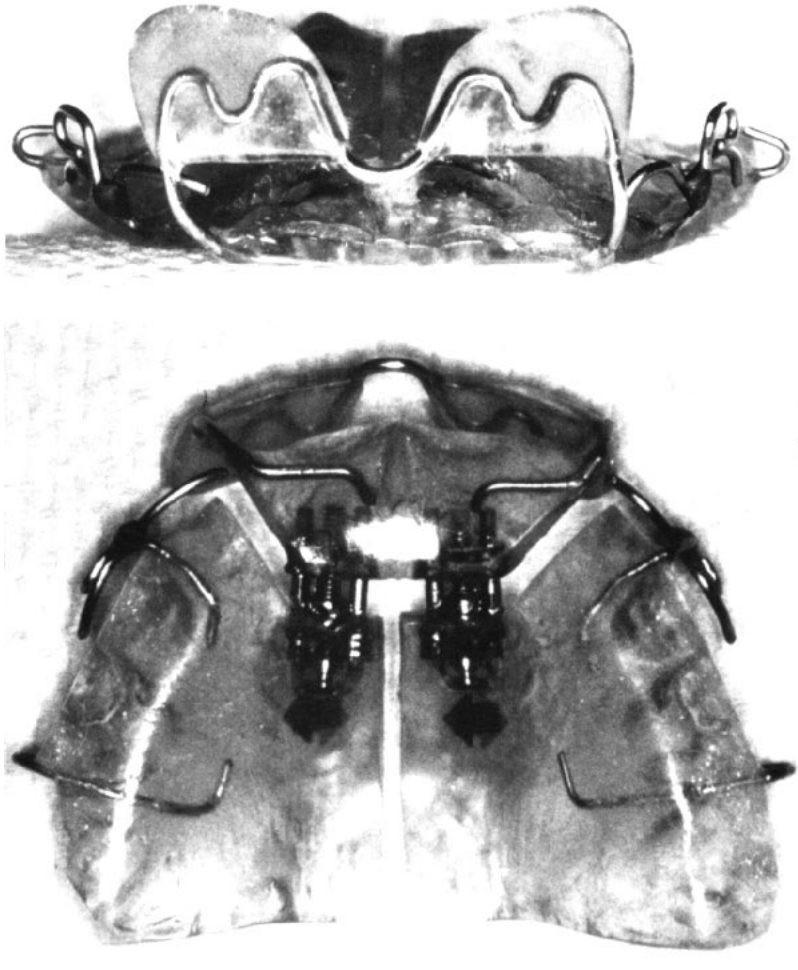

Fig. 8 The intraoral component of the protraction appliance.

— Discussion —

This case confirms that considerable nonsurgical protraction of the maxilla is possible during the mixed dentition stage of development. If excessive growth does not prevail, then this type of treatment may completely resolve the problem. At worst, the extent of future correction and possible surgical repositioning will be reduced.

In the Authors' experience, variations in success of nonsurgical maxillary protraction for individuals of similar age groups using apparently identical methodology have been extreme, often "all or nothing". Such erratic results may be explained by the presence or absence of

partial patency of the premaxillary-maxillary suture.

If this is the case, it might be possible to develop predictors for the prognosis of Class III nonsurgical intervention. The first step is to attempt to visualize the open suture on the individual patient. Unfortunately, the suture is fine and serpentine, difficult to observe by available imaging methods. Even computerized tomography with three-dimensional reconstruction has provided inconsistent tracking of visible and quite obviously patent sutures in dried skulls examined by the Authors.

If an incisive suture which can be clearly seen radiographically exists in the palatal shelves, it may be possible to stimulate additional remodeling in this phylogenetically eliminated site of upper facial growth. This would be especially beneficial in the skeletal Class III malocclusions with a deficient maxilla. Individuals with a prognathous mandible who are able to tolerate a full facial profile might also be good candidates for enhanced protraction of the maxilla.

— Conclusion —

While the patency of a premaxillary-maxillary suture was not diagnosed prior to treatment of this individual, the success of the treatment suggests such a condition. Obviously there is a need for further clinical and anthropological research in this field, together with retrospective correlation between success rates in the nonsurgical treatment of maxillary retrognathia and individual and racial dimorphisms.

References

Anderson, H., and Matthessen, M. 1967. Histochemistry of the early developement of the human central face and nasal cavity with special references to the movements and fusion of the palatine processes. *Acta. Anat. Basel* 68:4, 473-505.

Ashley-Montague, M. F. 1935. The premaxilla in the primates. *Quart. Rev. Biol.* 10:32-9, 1981-2008.

Delaire, J. 1978. The potential role of facial muscles in monitoring maxillary growth and morphogenesis, Muscle adaptation in the craniofacial region. *Monograph #8, Craniofacial Growth Series*, Carlson, P., and McNamara, J., Ed. Ann Arbor. 157-80.

Delaire, J., et al. 1972. Quelques resultats des traction extraorales a appui fronto-mentonnier dans le traitment orthopedique. *Rev. de Stomatol.* 73:633-42.

Hollinshead, W. H. 1974. *Textbook of Anatomy*. Hagerstown:Harper and Row.

Irie, M, and Nakamura, S. 1975. Orthopedic approach to severe skeletal class III malocclusions. *Am. J. Orthod.* 67:377-92.

Mosher, H. P. 1909. *The influence of the premaxilla upon the form of the hard palate and upon the septum*. Items of Interest. New York. pp. 481-515.

Nanda, R. 1980. Biomechanical and clinical considerations of a modified protraction headgear. *Am. J. Orthod.* 78:125-39.

Nanda, R., and Goldin, B. 1980. Biochemical approaches to the study of alterations of facial morphology. *Am. J. Orthod.* 78:213-26.

Noback, C. R., and Moss, M.L. 1953. The topology of the human premaxillary bone. *Am. J. Phys. Anthropol.* 11:181-7.

Ricketts, R. 1975. *The application of computers to orthodontics - diagnosis, prognosis and treatment planning*. Transactions of the Third IOC. pp. 169-84.

Rygh, P., and Tindlund, R. 1982. Orthopedic expansion and protraction of the maxilla in cleft palate patients - a new treatment rationale. *Cleft Palate J.* 19:104-12.

Schwartz, J. H. 1982. Dentofacial growth and development in home sapiens: evidence from perinatal individuals from punic carthage. *Anat. Anz. Jena.*152:1-26.

Sicher, H. 1965. *Oral anatomy*. Fourth ed. pp. 118-112. St. Louis:C.V. Mosby.

Subtelny, D. 1980. Oral respiration: Facial maldevelopment and corrective dentofacial orthopedics. *Angle Orthod.* 50:147-64.

Woo, J. 1949. Ossification and growth of the human maxilla, premaxilla and palate bone. *Anat. Rec.* 105:737-53.

Wood, N. K.

1967. The premaxilla: Embryological evidence that it does not exist in man. *Anat. Rec.* 158:485-90.

Wood, N. K. 1969. Osteogenesis of the human upper jaw: Proof of the non-existence of a separate pre-maxillary centre. *Arch. Oral Biol.* 14:1331-41.

Wood-Jones, F. 1925. *The ancestry of man*. Brisbane.