Highlights In Recent Foreign Literature

ARTHUR H. CRAVEN* D.D.S., M.S.,

East Lansing, Michigan

INTRODUCTION

I have been asked to present the "highlights" of the foreign literature during the past few years. This has left me pondering as to what constitutes a "highlight". Should it be a momentous accomplished achievement, of which there are few, or should it hold the potential for greatness and thus provide a stimulus for young investigators in this country? I have gathered both.

The fascinating field of orthodontics transcends so many disciplines of scientific investigation that it would be impossible to present them all. Thus this review will be limited, perhaps to those "highlights" which I believe are important. Both fundamental and applied research in the field of orthodontics have been grouped since there should be no dichotomy in our thinking. Similarly I have made no geographical barriers. Although certain areas of the world have produced a large amount of original research, isolated workers in the smaller countries have contributed in no small measure to our total knowledge.

The United States orthodontic journals are to be commended on their abstracting and reprinting of foreign publications. In most instances there may be a time lag of a year or two, but the major advances in the foreign field are well represented. Wherever possible I have omitted articles which have been published overseas and reprinted in detail in our own periodicals. Conversely I have eliminated articles written in the United States and published in the European literature.

This paper has four main divisions. The first is the problem of craniofacial development, the second orofacial musculature, a third the general field of cephalometrics and fourth, researches having a direct bearing on treatment.

CRANIOFACIAL DEVELOPMENT

In an imposing array of papers J.H. Scott has presented a theory of facial growth which differs from that generally accepted in North America. Largely on the basis of comparative anatomy and embryology, Scott has offered the suggestion that the vomer and the median nasal cartilage are the pacemakers in the development of the middle face. The thesis is that the median nasal septum is a projection of the chondrocranium into the facial area and, as the cartilage grows, it carries the premaxilla and maxilla downward and forward. This mechanism is assumed to be responsible for snouting in animals which have a separate premaxilla, that is, growth separating maxilla from premaxilla. In the human the early fusion of the premaxillary-maxillary suture is responsible for carrying the facial mask forward until the time of eruption of the permanent molars. After this time surface growth is allegedly responsible for most of the facial growth. Recently Scott has suggested that it may be possible that sutural growth continues after the first decade of life.

Naturally this places an increasing emphasis on the role of the facial sutures. In Scott's theory these sutures would be under a certain amount of tension. Thus it was of great interest to

*Associate Professor of Dentistry (Orthodontics), University of Michigan

see a paper published by Pritchard which investigated the role of the facial sutures. Pritchard's paper dealt with the histology of the growing facial and cranial sutures and tended to confirm Scott's belief that the sutures were not under pressure. The material was embryologic and comparative. Although there was a slight difference in the formation between the cranial and facial sutures, it was concluded that, "sutures form a strong band of union between adjacent bones while permitting slight movements, and at the same time allowance was made for marginal expansion of the bones during the growing period".

On the other side of the globe, Murphy in Australia was investigating the growth and function of the mandible. In so far as mandibular growth was concerned, Murphy employed an elaborate method of superposing tracings of mandibles and showed how the basic form or core of the mandible, originally straight, became progressively bent with age. This implied directional growth at the head of the condyle.

That such directional growth was likely and did occur was shown by Bjork. In a novel way Bjork placed small vitallium implants in the alveolar and basilar portions of the dental arches in a limited number of humans. In effect this was a series of metallic implants which were then followed by serial radiographs. Despite the loss of many of the implants through modelling resorption, definite trends in facial growth and directions of eruption of the dentition were shown. By superposing the radiographs of the metallic implants a directional growth of the condyle was shown. Growth may be in a vertical or horizontal direction. Although this paper was a preliminary report it aroused considerable speculation as to the amounts and directions of facial growth. In addition to implants in humans Bjork is presently carrying out implant techniques in the Macaca rhesus.

Together with the facial area considerable attention has been directed to the growth of the cranial base. In this regard there have been two significant contributions. Baume, in an endeavor to understand the changes which are liable to occur at sella turcica, performed a histological study of the cranial base of the Macaca rhesus. He came to certain interesting conclusions: first, that the synchondroses act as epiphyseal cartilages, but differ in that bone is being deposited on both sides of the cartilage; second, that growth at the synchondroses is governed by genetic and endocrine factors; lastly, that there is continuous bone transformation at sella turcica and the clinoid processes, the implication being that there could be considerable movement occurring at sella point.

In an investigation of the growth of the cranial base of the Macaca rhesus, Lager, (working in Bjork's laboratory) employed metallic implants in the cranial base on each side of the spheno-occipital synchondrosis. He concurred with Baume in the histology of the cranial base and, in addition, presented the idea that there existed a differential in growth along the spheno-occipital synchondrosis so that there was a greater amount of growth on the more inferior area. In this fashion he explained the flexion of the cranial base as occurring in growth.

Continuing investigations from the Vasteras growth study, Bjork has reported several cephalometric studies. Together with Jensen and Palling an interesting paper on mandibular growth and third molar impaction concluded that impaction may depend upon three factors: 1) a reduced growth rate in length of the mandible, 2) a vertical direction of growth of the condyle, and 3) the backward eruption of the dentition. The vertical direction of growth of the condyle was claimed to have the greatest effect. A retarded maturation of the mandibular third molar was also related to impaction.

Further reports have been published from the Burlington, Ontario, Longitudinal Growth Study. Now in its eighth year, this longitudinal cephalometric study under the auspices of the University of Toronto has produced a few interesting papers. Notable are those by Hatton which deal with the rate of movement of unerupted teeth and the inheritance of features of dental eruption. Cephalometric standards for various age groups, three, six, eight and ten years have been established. The standards are in the form of dispersal of points around the mean measurements. Thus there is some interpretation of individual variation in growth.

Perhaps one of the most important papers of recent years was that of B. Lindegard entitled, *Variations in Human Body-build.* Lindegard was searching for a method of describing body-build and included in his investigation x-ray cephalograms. Of importance to the orthodontist were measures of body build showing correlation to measurements in the craniofacial region. Lindegard recalled patients, of whom Bjork had recorded cephalograms in Vasteras, applied somatic measurements and took body-build photographs. On the basis of the division of body-build into bone, muscle and fat tissues, Lindegard reported a bony length factor (for example, radius length and tibia length) indicative of endochondrally-formed bone and a sturdiness factor (for example, breadth of the femoral condyle) indicative of appositionally - formed bone.

Many correlations between facial measurements were made including the correlation between the freeway space and facial form. In this latter respect a more parallel mandibular plane angle to S-N was reported to be correlated with a wider freeway space.

Although some of the correlations were weak, Lindegard pointed out that the predominance of either the length factor or the sturdiness factor showed some relationship. Thus "a large length factor is seen in association not only with a weak cranial base bend (wide cranial base angle) but also with a long mandibular base and a large upper face height, both anterior and posterior heights. A large sturdiness factor is related to large lengths of the cranial (S-N) and mandibular bases as well as of the upper and lower face. Thus the anterior cranial base length, the mandibular base length, the length of the maxillary body, the maxillary protrusion (sella to ptm) and the alveolar prognathism are, as a rule, large in the presence of a large sturdiness factor".

A short paper by Bjork on *Bite Development and Body Build* brought Lindegard's work to the attention of the orthodontist. Bjork extended the use of body-build examination by comparing body-build to the dental arches. He inferred that skeletal sturdiness would be accompanied by dental arches big in all dimensions and with large teeth in both jaws. Slender skeletal structure seemed to Bjork to be related to a relatively narrow maxillary dental arch compared to the mandibular arch. There was also a positive relationship between body-build and tooth eruption in that earlier eruption was associated with skeletal sturdiness. Bjork went one step further and analyzed the body build of patients under orthodontic treatment with bite plates. He checked the progress of treatment by the use of cephalograms and reported a significant difference in response to treatment, the sturdily built children responding more rapidly. In order to compare alveolar response to treatment a small portion of alveolar bone was removed from members of each group. Histological examination showed a difference in periosteal bone growth.

In 1956 many papers at the European Orthodontic Society meeting dealt with the problem of body build and facial typing. There were notable papers by Autissier, Muzi and Berger. Despite the diversity of body-build classification and different treatment procedures there was evidence that the orthodontist could benefit by examining the whole child.

With this interest in mind it was of some importance to consider the factor of growth with its effect on somatotype or body-build. One of the most interesting texts recently published is that of J. M. Tanner entitled *Growth at Adolescence*. The book is devoted to a study of the developmental changes occurring in children during the period in which we orthodontists are treating. All aspects of the child were considered and it is commendable that longitudinal data from cephalometric studies in the United States had been incorporated. Although it may be subjective, the maturation of the soft tissues of the face was presented.

Tanner was fortunate in being able to secure body measurements of adults which had formerly been somatotyped as children. With this data prediction of adult size could be made from that of the child. It was significant that prediction from the four to six year old group was more accurate than prediction during the pubertal period. Of course, after puberty prediction became quite accurate. This led Tanner to conclude that if one plotted a growth curve for a child the period of puberty became a period of disturbance and the child eventually returned to the regular curve of growth.

That the pubertal period indeed upset growth curves was shown by Nanda who published in detail in the German literature. As you may remember, Nanda showed maximum growth rates of the various facial dimensions occurring at different times relative to the circumpubertal maximum in body height. He concluded that growth of the face had its maximum circumpubertal amount slightly later than that for the general body height.

The possibilities for applying biometrical methods to longitudinal data were well presented by Tanner. In the Northcroft Memorial Lecture to orthodontists, Tanner showed the applicability of formulae to resolve the question of prediction of facial growth. He suggested that improved biometrical formulae devised by Medawar and others may be applied to the longitudinal data available in the United States. By this means significant deviations in facial growth could be detected and have predictive value. To this reviewer it seems as though a thorough survey of the significance of the craniofacial landmarks and measurements in current usage would be the first step. It is equally obvious that a coordinate system involving linear measures is the only practical means of applying growth equations.

Orofacial Musculature

There has been an increasing interest in the influence of the facial muscles and mechanisms of deglutition on the dentition. Following the tradition of Rix, Gwynne-Evans and others, it is not surprising that Tulley applied electromyographic techniques to the facial musculature and the mechanism of swallowing. In 1957 Tulley reported the activity of the labial musculature in the chewing of various types of foods. In normal occlusion the chewing of a biscuit led to little lip activity on deglutition, but when a piece of orange was chewed and swallowed there was considerable lip activity. In cases exhibiting a malocclusion there was excessive circumoral activity.

It seems to this reviewer that two very interesting papers on the lips have been by-passed in the field of electromyographic research by orthodontists. In a paper entitled *Facial Reflexes* and a later paper *Perioral Reflexes* Kugelberg and his associates have studied reflex contracture of facial muscles from light tapping. Although the neurological mechanisms involved are not completely understood, the resultant contracture of the perioral muscles varied in the few patients reported. Reflexes were observed in the mentalis muscle together with the orbicularis oris. The variants in response would seem to be of significance to the orthodontist.

That the perioral musculature has pronounced variation in the spatial arrangement of its muscles has been well shown in the Japanese lips by T. Namiki. In careful dissection of the lip area of twenty-seven cadavers Namiki has shown the tremendous variations of the insertion of zygomaticus major and triangularis to the orbicularis oris muscle. It is presumable that similar variation exists in occidental lips.

In order to answer the question as to whether the teeth are in contact during deglutition and mastication Posselt applied a layer of wax over the lower teeth and then applied an electromyographic technique to the masticatory muscles. The wax was examined for perforations. It was found that most patients make contact with the teeth during deglutition and mastication; that the position of the contact was in the habitual closure position of the mandible (rather than terminal hinge position); and that the mandible did not seem to make any gliding movements but moved directly to the intercuspal position.

Movements of the mandible and the anatomy of the temporomandibular joint have been the fields of investigation of Murphy in Australia. Using a comparative anatomical approach and examining the path of wear of the human dentition and TMJ, Murphy concluded there was pressure transmitted through the joint. In evidence of this pressure he showed anterior and posterior facets in the glenoid fossa which coincide with an anterior and posterior facet at the head of the condyle. Murphy suggested these are functionally separate areas. Thus on the side of function the anterior facet of the condyle was against the anterior facet of the glenoid fossa; on the pivotal side the posterior facet of the condyle was against the posterior facet. This latter facet was supplied by the postglenoid process. The pivotal side was pre-set and held in place by action of posterior temporal fibers.

Fundamental to muscle is its ability to grow as the facial skeleton grows. Thus it was of interest to note Symons' paper on *The Attachment of the Muscles of Mastication*. Symons divided muscle attachments into those applied to the periosteum and those with a tendon insertion into bone. Muscles with tendonous insertion were investigated in the fetal period. It was found that continual adjustments of breakdown and restoration of tendon fibers, and bone resorption and deposition were the means of adjusting during the period of growth.

Of perhaps a more fundamental nature was Crawford's study of muscle growth. His experiment was devised to alter the distance through which a muscle had to contract in order to produce its normal degree of movement, with the intention of determining whether this lead to any alteration in the extent of its ultimate growth. Young rabbits were used and the normal amount of growth determined by exposing the muscle (tibialis anterior) and placing ink marks or passing fine wire through the belly of the muscle. In the latter case serial x-rays showed the positions of the wires; it was found longitudinal growth occurred throughout the length of the muscle belly.

The muscle action was lengthened by cutting the crural ligament and permitting the tibialis anterior to work through a wider range of movement. After twelve months growth the normal muscle and lengthened muscle were compared. It was found that the tendon on the operated side was shorter than normal and the muscular belly greater. Thus the length of the belly of muscle was increased from the greater distance in which it had to contract.

Whether similar occurrences take place in the masticatory musculature is perhaps debatable, but the possibility of lengthening muscle is of interest in bite-opening procedures.

Cephalometrics

In 1954 Bjork wrote an excellent compilation of our present status in cephalometric roentgenology. Since that time there has been an increased usage of cephalometrics by the clinician. Numerous analyses have been devised, the most notable being that of Korkhaus. Another was that described by Schwartz which dealt not only with the bony profile but also took into account the distribution of the soft tissue. In Italy the cephalometric analysis of Muzi included the inclination of the forehead as it influenced the interpretation of the profile.

Needless to say these individuals, using different landmarks, have created a degree of confusion in definition and terminology. It was not surprising to find the European Orthodontic Society, in 1956, setting aside a subcommittee under the direction of Bjork to assess and evaluate cephalometric planes and landmarks. About the same time the French orthodontists convened for a similar purpose and clearly defined about ten craniofacial landmarks. Although the definition of landmarks may tend to arrest the progress of cephalometric research, the clarification of points and planes certainly assists the clinician.

As well as the growth studies which have been mentioned above, the field of cephalometrics has been applied to anthropology. In 1957 Sarnas published a cephalometric analysis of growth changes in ancient man in North America. He compared the growth of a selected series of Indian skulls, grouped by dental age, with Swedish and Australian native groups. Many features of the ancient Indian were common to either the Swede or aboriginal living today.

Recently the relationship of head posture and cephalometrics has been investigated by Bjerin. In an attempt to establish some standard of head balance Bjerin took cephalograms and oriented head photographs of thirty-five subjects in both standing and sitting positions. He found great variation in the inclination of the Frankfort horizontal to the true horizontal and considered that the posture of the head should be accounted for in any profile analysis.

As an extension of the metallic implant technique devised by Bjork and reported earlier in this paper, Lager reported on the effects of orthodontic treatment by superposing cephalograms on metallic implants placed before starting treatment. Thus lateral cephalograms and implants served to show tooth movements as a consequence of orthodontic treatment.

Clinical Research

Largely due to the influence of Begg, most orthodontists in this country are now aware of the effects of light forces in orthodontic treatment. However, behind Begg's work was the research of Storey in Australia. In an enlightening series of papers he reported bone changes in experimental animals. Storey applied different amounts of force to the incisor teeth of rodents. He found that there was an optimum range of force for each species. Of orthodontic importance was the observation that this optimum range of force may be determined for the human to produce the maximum rate of tooth movement. Storey also observed the effects of the duration of forces on the teeth and suggested that light, continuous forces be used with periods of rest so that bone may be reformed ahead of the tooth. It was observed that new bone formation occurred at a slower rate than bone absorption. Lastly, Storey observed the effect of sex and age on tooth movement. As would be expected, there was a decrease in the rate of bone resorption with increasing age.

In two clinical papers Smith and Storey offered the suggestion that the usual force employed to retract cuspid teeth was such that "undermining resorption" occurred on the cuspid and "physiologic tooth movement" at the molar. Thus there was a tendency for the molar, due to its larger root area, to move mesially more rapidly than the cuspid moved distally. They offered the possibility of forces light enough to be "physiologic" at the cuspid and practically negligible at the molar.

This same general feeling was echoed by Reitan in a discussion of the forces in orthodontics. He suggested light forces for the initial movement of the teeth. He did mention that greater forces may be necessary in the final positioning of the teeth due to the tension of the fiber bundles.

The effects of these gingival fibers on the rotation of teeth has been shown by Reitan. Some of this paper has recently been published in the American literature. Of particular significance was the long period of retention required to permit adaptation of the marginal fibrous tissue.

In the recent European literature considerable emphasis has been placed on the rapid expansion procedures in the maxilla. In 1956 Derichsweiler reported good results in a large number of cases treated by expansion. Later he reported experimental expansion of the median palatal suture in the macaque monkey. He varied the rate of expansion and found that slow (or biologic) expansion had little effect on the palate. On the other hand rapid expansion resulted in emergency bone deposition in the region of the nasal septum and six months later the area appeared normal.

A clinical paper by Gerlach showed that there was an increase in the human apical base after rapid expansion. His method of examination was similar to that used by Howes and concerned gain in width of the apical base.

One of Bjork's students, Krebs, has adapted the use of metallic implants to determine the effects of rapid expansion procedures in orthodontic treatment. Implants were positioned on the infrazygomatic ridge and in the palate, lingual to the cuspids. It was assumed that the former implants would show separation of the maxillae while the latter the expansion of the alveolar ridges. Frontal, lateral and standard occlusal roentgenographs were taken. Although only one case was reported, it was found that the dental arch was increased in width more than the basal arch and that there was a tendency of the basal arch width to lessen during the period of retention.

That arch length may be influenced by the premature extraction of deciduous teeth was shown by Clinch on longitudinal data extending over an eleven year period. Casts were taken at annual intervals between three and fourteen years of age. She concluded "that extractions before the eruption of the first permanent molars resulted in permanent loss of space, but to a varying degree and more in the upper than in the lower arch; secondly, that well-developed arches showed little, if any, permanent space loss following later extractions".

The last area which I would like to comment upon is that of the treatment of the cleft lip and palate patient. In 1954 McNeil published on the early orthodontic management of these patients. Although there was considerable controversy concerning the effects of this treatment on the arch form of the cleft palate patient it was of some value. By 1958 Burston reported on the use of the McNeil technique. Much of the paper was a review of the embryology of the oral cavity and a discussion of the role of the nasal septum during the fetal period; however, the effectiveness of early treatment was well shown in a series of patients. In brief, McNeil's objective was to place the maxillary segments in such a position that the surgeon could readily close the lip. This avoids the typical collapse of the maxillary arch. Treatment was instituted as soon after birth as possible by a series of removable plastic appliances.

In 1958 Derichsweiler reported on the application of McNeil's work to the early cleft palate patient presenting favorable results. This year a further report by Hotz and Graf-Pinthus has shown the effectiveness of McNeil's procedure before lip surgery.

903 East Grand River Avenue

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