

SPECIAL ARTICLE

The speno-occipital synchondrosis: The missing link between the profession's concept of craniofacial growth and orthodontic treatment

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The role of the speno-occipital synchondrosis in craniofacial growth as it affects the spatial position of the upper face and maxillary dentition has been masked by the traditional method of superimposing cephalometric tracings on the anterior cranial base. Furthermore, the erroneous assumption that the overall direction of growth of the face is demonstrated by superimposing stable areas of the anterior cranial base has led to gross misinterpretation of treatment results throughout our literature.

(Am J Orthod Dentofacial Orthop 1998;114:709-12)

Growth of the speno-occipital synchondrosis, though appearing to be remote from the orthodontist's primary concern, influences the height and depth of the upper face and the spatial position of the upper teeth during orthodontic treatment.

The problem that has masked the role of the speno-occipital synchondrosis has been the traditional orthodox method of superimposing cephalometric tracings on the anterior cranial base to demonstrate the direction of growth of the entire face.

To understand this enigma and the resultant distortion of clinical concepts, one must examine the origin of the method of superimposing anterior cranial bases of serial cephalometric x-ray tracings. When Allan G. Brodie¹ published his historic article, "On the Growth Pattern of the Human Head: From the Third Month to the Eighth Year of Life," he superimposed anterior cranial bases in order to examine the growth behavior of skeletal structures "in relation" to the anterior cranial base. What should be noted are the words "in relation."

The following is a direct quotation from Brodie's dissertation:

It should never be forgotten that the superimposing of various points as centers is nothing more than a temporary assumption that may have no basis in fact. It can be stated with certainty only that one part behaves in such and such a manner in relation to some other part; i.e., that the distance between certain points increases in a certain direction and at a certain rate.

Years later when the profession began to apply cephalometrics to the interpretation of clinical treatment, Brodie's illustration of superimposing anterior cranial bases was misinterpreted as depicting the actual directional pattern by which the face grows. Thereafter, all cephalometric interpretation of clinical treatment was based on this misinterpretation.

Clearly, there is no problem with superimposing stable portions of the anterior cranial base to quantify relative changes within the cranial base, be it the planum sphenoidale and tuberculum sella, with a common sella point or the intersection of the greater wings of the sphenoid. Nor do I fault studies that quantify changes within the face relative to the anterior cranial base. The problem arises when the anterior cranial bases are superimposed to demonstrate the directional expression of growth of the entire face in order to interpret the skeletal effects of orthodontic treatment. What results is a complete dichotomy between concept of craniofacial growth and the cephalometric graphic rendition of concept. Unfortunately, the resultant effect has been a major distortion of clinical judgment since the time Brodie's original work was misinterpreted by the profession.

As an example of this dilemma, I shall use a research article recently published in the *AJO/DO* by Buschang and Santos-Pinto² entitled, "Condylar growth and glenoid fossa displacement during childhood and adolescence." The authors measured the vertical and horizontal increase in dimension between sella turcica, the condyle, and glenoid fossa during craniofacial growth.

If this work was limited to the measurement of increments, there would be no argument. The problem arises when the authors translate their quantitative findings to a description of the directional growth of the condyle

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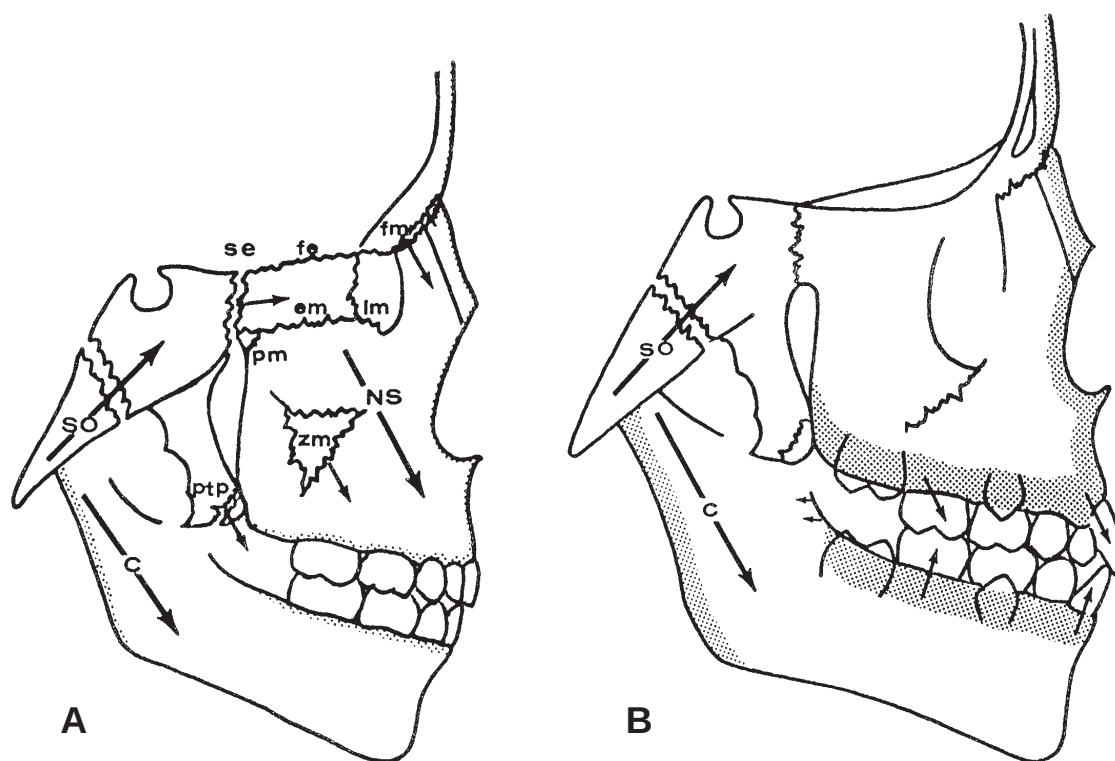


Fig. 1. A, Postnatal craniofacial growth systems to the age of 7 years (first decade). Cartilaginous growth: SO, Spheno-occipital synchondrosis; C, reflection of condylar mandibular growth; NS, nasal septum. Spheno-ethmoidal circummaxillary suture system: se, Spheno-ethmoidal; ptp, pterygopalatine; pm, palatamaxillary; fm, frontomaxillary; zm, zygomaxillary; zt, zygomaticotemporal (not shown). Surface apposition-modeling resorption development (stippled area); minor contribution. (Am J Orthod 1966;52:5-26) **B**, Postnatal craniofacial growth systems from age 7 (second decade). Cartilaginous growth: SO, Spheno-occipital synchondrosis—active through puberty; C, reflection of condylar mandibular growth—active to facial maturity; nasal septum—growth completed. Spheno-ethmoidal circummaxillary suture system: Sutural growth no longer primary system of upper facial development. Surface apposition-modeling resorption development (stippled area): Now major method of upper facial development and alveolar growth. (Coben. Growth and Class II treatment. Am J Orthod 1966;52:5-26)

and fossa. The measured increments are described as evidence that the condyle and fossa are positioned downward and backward from the pituitary fossa by growth, sometimes more vertically downward and at times more horizontally backward. This is the same concept expressed previously by Agronin and Kokich.³

This observation is not new for it has been demonstrated, although ignored, by superimposed tracings throughout the literature. The significance of the Buschang and Santos-Pinto and Agronin and Kokich articles is that finally they have focused on the area that represents the very distortion of concept that prevails throughout the profession. I welcome these articles not for their conclusions, but for their recognition that something back there is going on that can influence orthodontic treatment.

The behavioral phenomenon they have recognized

in the posterior cranial base is the result of the variable directions of growth of the spheno-occipital synchondrosis. The distortion of concept is that growth of the spheno-occipital synchondrosis does not translate the mandible downward and backward. Growth of the synchondrosis translates the anterior cranial base and its attached upper face upward and forward, away from the foramen magnum and the vertebral column.

To establish the underlying rationale behind such a profound critical statement, I refer the reader to my previous articles, Growth and Class II treatment⁴ and Biology of Class II treatment.⁵ Figs 1A and B are companion illustrations that represent the directional process of postnatal growth systems described in these articles.

To summarize the concept, the basic pattern of craniofacial growth is that growth of the spheno-occipital synchondrosis translates the anterior cranial base

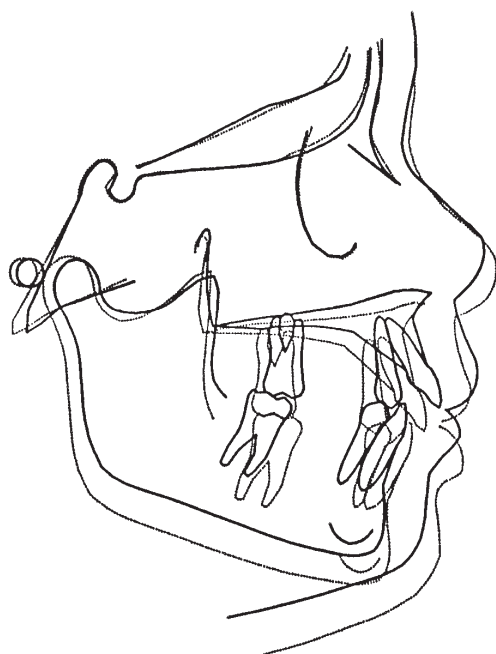


Fig. 2. Pretreatment and posttreatment tracings of Class II high-pull headgear patient. Condylar growth was masked by fossa relocation with minimal anterior chin displacement. (Buschang and Santos-Pinto. *Am J Orthod Dentofacial Orthop* 1998; 113:437-52)

and its attached maxillary complex upward and forward away from the foramen magnum. The mandible, maintaining a constant sagittal relationship with foramen magnum, grows downward and forward away from the cranial base. Between these two general vectors space is created for vertical development of the face and the eruption of the dentition. As the upper face is translated upward, the palate tends to maintain its general relationship with the foramen magnum to provide for velopharyngeal closure. It does this by resorption on the floor of the nose and apposition on the oral aspect of the palate.

In order that one may not conclude that this is just another academic discussion with little clinical relevance, I have chosen to reproduce and discuss Buschang and Santos-Pinto's tracings of the treatment of a Class II case (Fig 2). Bear in mind their method of superimposing anterior cranial bases to describe the overall growth behavior of the face is the traditional accepted method of superimposing tracings.

Buschang and Santos-Pinto used this Class II treatment tracing to graphically illustrate their observation, "greater than expected posterior fossa displacements" and their conclusion, printed in italics, "*posterior fossa*

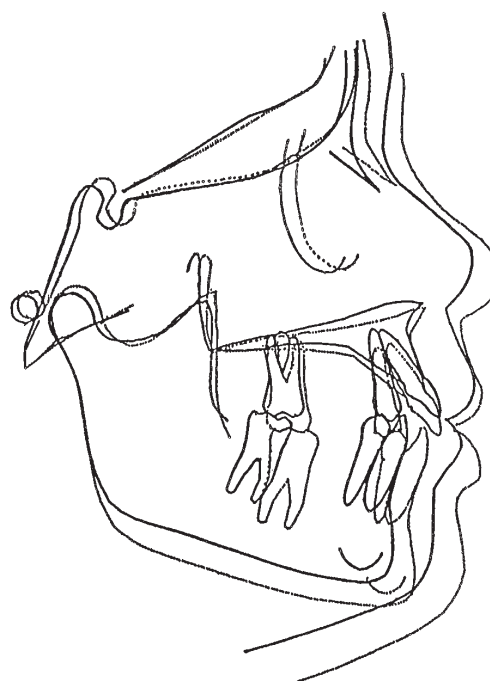


Fig. 3. Same Class II treatment case as Fig 2. Tracing resuperimposed registered at Basion with anterior cranial bases parallel as in Fig 2. (Coben)

displacements must be added to any existing anterior-posterior discrepancies and future growth deficiencies."

Their Class II treatment illustration reproduced in Fig 2 shows there was substantial growth of the mandible, yet the symphysis moved downward and only slightly forward. This small forward movement of the symphysis is interpreted by Buschang and Santos-Pinto as the causative effect of the backward movement of the mandible by the cranial base during the time of treatment. Although not commented on, the maxillary molar and incisor also can be seen to occupy a more downward and backward position in the face.

When Buschang and Santos-Pinto's tracings of the Class II case are reregistered at Basion (Fig 3), significant differences of interpretation of craniofacial growth and the effects of orthodontic treatment become self-evident. As expected, the Basion-Articulare relation did not change, a finding I first described in 1955.⁶ On the basis of our subsequent serial work from age 1 year, I have claimed that the sagittal relationship of Articulare to the anterior border of foramen magnum, Basion, does not change postnatally.⁷⁻⁹ As such, the Basion-Articulare relationship may be viewed as a zone of orientation to visualize the expression of the direction of facial development in height and depth.

The horizontal spatial change seen at the pituitary

fossa is the reflection of the direction of growth of the spheno-occipital synchondrosis. In this case, growth of the synchondrosis translated the upper face and the maxillary complex almost totally forward to increase the depth of the upper face with little change in height. In another person, growth of the synchondrosis may be expressed completely vertically to contribute primarily to upper facial height. Not only does the direction of growth vary between persons, but also it varies within the individual craniofacial pattern. At one stage growth may be more vertical, then more horizontal, and change again after a prepubertal plateau. What is significant is that whatever the direction of growth of the synchondrosis, this growth translates the upper face and the maxillary dentition away from the foramen magnum.

Growth of the synchondrosis varies in rate and maturation as well. It can accelerate, decelerate, again accelerate after a prepubertal plateau, completing growth at the end of the pubertal cycle. Cessation of the spheno-occipital growth also varies according to general maturation and sex, with earlier closure in females and later closure in males.¹⁰

When one looks at the dentition in the Basion registration illustration, the upper molar after treatment is spatially positioned downward and forward in the face. Although the upper molar was distalized within the maxilla relative to PTM^{AQ3}, the maxilla itself was translated forward to the degree seen at the pituitary fossa and PTM. In this case, the molar is found to be slightly forward spatially because the horizontal translation of spheno-occipital growth was slightly greater than the amount of molar distalization.

The same process applies to the upper incisor region. The posttreatment depth position of the upper incisor and subnasal tracing show little spatial change relative to the foramen magnum, Basion. In reality, incisor retraction and inhibition of subnasal apposition or resorption of bone equaled spheno-occipital horizontal translation of the maxilla. Subnasal increment generally keeps pace with increment at Nasion since the entire upper face is being translated forward and surface apposition of bone on the entire fronto-maxillary surface tends to be similar. Greater apposition in the midface is seen in cases of true midface prognathism and minimal apposition in true midface deficiency.

In the lower face, one can see that the condyle of the mandible maintained its anterior-posterior relationship to foramen magnum, Basion. As the maxillary complex was restricted by head gear, mandibular growth carried the lower arch downward and forward to a Class I occlusion. With this mandibular growth, had the expression of spheno-occipital growth been more verti-

cal, correction to Class I occlusion may have been easier to attain.

To put it in simple terms, the problem is that the profession has been looking at the growth process backwards. The concepts expressed here are not recent; the essence of the Coordinate Analysis that I published in 1955 was the quantitative and graphic portrayal of these very concepts. Since that time our research and conclusions of clinical experience have only substantiated these concepts. All of this work is embodied in the Basion Horizontal Coordinate Analysis and Graphic Computer System¹¹ and in the monograph, Basion Horizontal.¹²

I apologize if it appears I have been unduly critical of Buschang and Santos-Pinto's article for they are not at fault. They are merely following uncontested misinterpreted dogma. The literature is replete with such erroneous treatment conclusions.

Like a phantom, growth of the spheno-occipital synchondrosis influences all growing faces and is a factor in the treatment of all children. Great emphasis has always been placed on mandibular growth. Lest this commentary be misunderstood, a finite understanding of the growth, size, form, and spatial position of the mandible is essential to our understanding of craniofacial growth and treatment, but it is only the lower half of the process. Growth of the spheno-occipital synchondrosis is part of the upper half of the equation of the interrelation of craniofacial growth and orthodontic treatment.

As our profession reaches out to the new millennium, not only must it advance technologically, but also it must reassess its treatment principles. The time has come for a change in concept otherwise the profession is destined to continue the mistakes of the past. Concepts cannot be perpetrated by tradition alone. They must withstand the challenge of question.

The hour is late and the work is yet undone.

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