A CEPHALOMETRIC ANALYSIS OF SKELETAL THREE APICAL BASE RELATIONSHIPS IN FAMILIES

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Introduction

Children resemble their parents in many ways and geneticists have identified many specific characters to enable them to analyse in what ways children look like their parents and how these likenesses are transmitted. Progress has been made on the genetics of the eye, hair colour and certain facial features; and recently an increasing number of studies on familial resemblances have appeared: lip morphology has been studied by SARNAS (1959), bony morphological features by KRAUS et al (1959), endocranial and mandibular outline by BROWN (1961), and MOORREES (1962) has demonstrated the usefulness of his mesh diagram for analysis of facial morphology. These studies have re-emphasised the value of investigating families and have led to the present paper which is an analysis of the incidence of a skeletal three apical base relationship among 50 families. A skeletal three apical base relationship was defined by BALLARD (1948) as one in which the mandibular apical base is anterior to the maxillary apical base.

Methods and materials

Fifty families each with at least four children with the youngest not less than 6 years had lateral cephalometric radiographs and photographs taken. For half the sample study models were made. The lateral radiographs were taken with the teeth in occlusion. For the 45 parents who were completely or partly edentulous the radiographs were taken with the mandible at rest.

Altogether there were 230 children of whom 111 were males and 119 females. Their ages ranged from 6 to 32 years with a mean age for the males of 15.4 years and for the females 13.9 years.

Tracings from the lateral radiographs were made of the sella turcica, the junction of the nasal and frontal bone and the anterior outlines of the maxilla

and mandible. On these tracings the following points were identified:

S the centre of the sella turcica
N the junction of the nasal and frontal bone
A the point of greatest concavity on the anterior outline of the maxilla
B the point of greatest concavity on the anterior outline of the mandible.

The SN, NA, NB points were joined and the SNA/SNB angles measured.

Normally the A point on the maxilla is anterior to the B point on the mandible and $\angle$SNB subtracted from $\angle$SNA gives a positive value. Where $\angle$SNB was larger than $\angle$SNA a negative value was recorded. For this sample all cases which had a zero or negative difference between their SNA and SNB angles were classed as skeletal three, and this conforms with the definition given by TULLEY and CAMPBELL (1960).

To analyse the sample, tracings were made from all the radiographs and the SNA and SNB angles were measured.

Group I – There were 18 families in which at least one parent had a negative difference between their SNA and SNB angles and these 18 families comprise Group I. Altogether there were 81 children belonging to this group.

Group II – This group consisted of another 18 families in which at least one parent had a 1° to 2.5° difference between their SNA and SNB angles. There were 73 children.

The remainder of the sample was discarded; it was comprised of families in which both parents had an SNA/SNB difference in excess of 2.5° or those in which convincing identification of A and B points could not be made.

Because the basis of selection of these families into two groups was dependent on the identification of the A and B points, Table 1 was constructed to show the incidence of complete and incomplete labial dentitions among the parents. There were 39 who were completely edentulous. 5 edentulous in the maxilla only, 1 edentulous in the mandible only, while the remaining 27 parents had complete labial dentitions.

There do not appear to have been any studies on the changing of the A and B point locations after the incisors have been extracted; and in the absence of such studies it was decided to accept the hypothesis that the A and B points did not change significantly after the teeth have been extracted. There is some evidence to support this thesis in the sample itself. Among the five parents who had lost their maxillary incisors but still had their lower incisors four out of five had their A points anterior to their B points. Their SNA/SNB differences were respectively $+6°$, $+5°$, $+4°$, $+2.5°$, and $-1.5°$. Besides the evidence of the sample there is the experience of the prosthetist who finds that the ridge of the maxilla resorbs more slowly than that of the mandible.

The Labial Occlusion

For half the sample this was studied from the study models, and for the remainder directly from the radiographs. Assessment was made of the incidence

of reversed overjets in which the maxillary incisors were lingual to the mandibular incisors; for the incidence of edge to edge occlusions and finally for the frequency of measureable overjets. A measureable overjet was defined as one in which there is no contact between the palatal incisal edge of the maxillary incisors and the labial surfaces of the mandibular incisors.

Findings

The SNA/SNB Differences

The mean, range and standard deviation of the differences between |SNA and |SNB were determined for the mothers and fathers separately (Table 2). The means for the mothers and fathers were 3.2° and 2.7° respectively. The 8° upper limit of the range emphasises the extent to which the B point may be behind the A point.

Among these 50 families there were 18 of whom one or both parents had an SNB angle higher than their SNA angle, and had therefore a skeletal three apical base relationship. These 18 families comprise Group I. Another 18 families in which one or both parents had an SNA angle 1.0° to 2.5° higher than their SNB angle, that is a skeletal one apical base relationship, were designated as Group II. If one parent had a negative SNA/SNB value or a

Fig. 1. Family 1. The profiles reveal general similarities and differences.

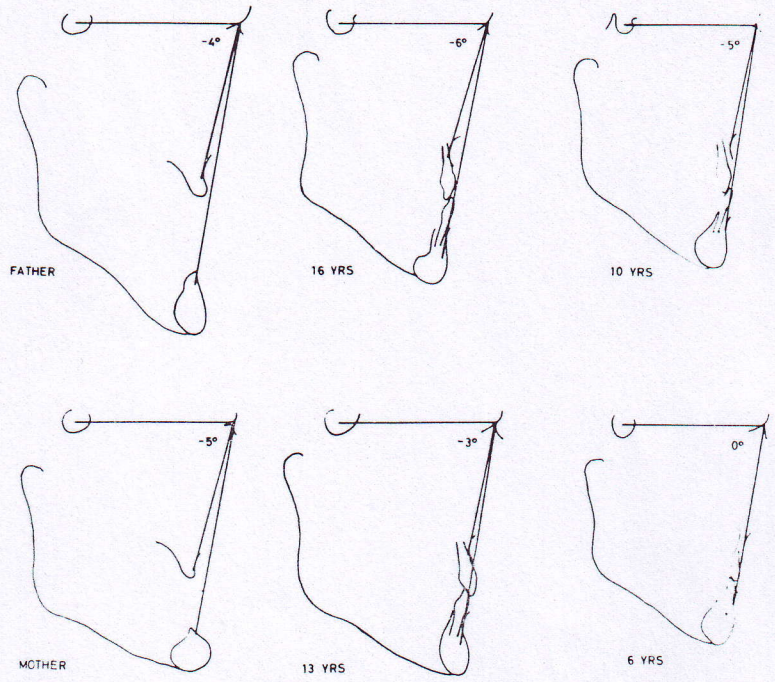

Fig. 2. Family 1. The tracings are arranged in the same order as the photographs in Fig. 1.

1.0° to 2.5° value the other parent's SNA/SNB difference could range from a negative value to a +8° difference.

The SNA/SNB differences in two families from Group I

Family 1 – The photographs and tracings from the lateral cephalometric radiograph demonstrate in Figs. 1 and 2 the facial and dental similarities and differences of one of the families of Group I. The profile photographs of this family show general likenesses between the children themselves and between the children and the parents, but it is, however, quite difficult to guess at the underlying skeletal pattern or the occlusion of the teeth. It looks at first glance from these photographs that mandibular B point of the mother is much further in front of the A point of her maxilla than is the B point in front of the A point for her husband; and yet reference to Fig. 2 shows only a slight variation in the SNA/SNB differences of the two parents; and again the 16

year old daughter looks much more like her 13 year old sister than her 10 year old sister; though in fact, skeletally and occlusally she is more like the latter *(Fig. 2)*.

The SNA and SNB angles of the six year old brother are coincident. His deciduous teeth are in normal occlusion, and though at the moment his permanent incisors look as if they too will come into normal occlusion it remains to be seen what will happen.

To sum up then these two parents, both with a skeletal three apical base relationship, have four children, three of whom have SNB angles higher than their SNA angles whilst the fourth child, a boy, has SNA/SNB angles that are coincident.

The two girls with the -6° and -5° differences have reversed overjets with their upper incisors lingual to their lower incisors whilst the 13 year old girl and her brother have potentially normal occlusions.

Family 2 – The second family, again from Group I, shows again two parents with a skeletal three apical base relationship, but three of their children have a positive value and only one a negative value. As before the photographs *(Fig. 3)* reveal strong family likenesses. The lip morphology of these two families seems to be characteristic for each family.

Fig. 3. Family 2.

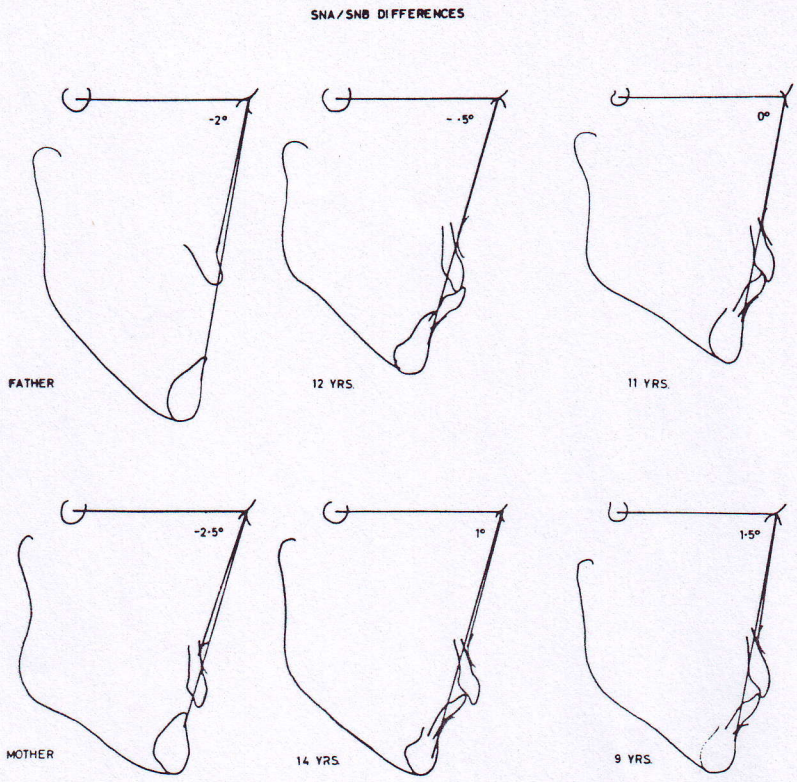

Fig. 4. Family 2. The Tracings are arranged in the same order as the photographs in Fig. 3.

Details of the occlusion are shown in Fig. 5. All the children, it will be noted, have a normal molar relationship; only the elder brother with SNA/SNB difference of — .5° has his maxillary incisors lingual to his mandibular incisors. It should be noted that the overbite of the youngest child is larger than was apparent in the cephalometric tracing and this is because the study models were taken later than the radiographs.

Both parents of these two families were edentulous, the anterior outlines of the mandible and maxilla have been quite easily outlined on the tracings.

SNA/SNB differences for Group I and II

The detailed analysis of the two families illustrated above indicate the nature and scope of the project. Table 3 gives a breakdown of the skeletal three tendency for the two groups.

The incidence of a skeletal three apical base relationship among the children

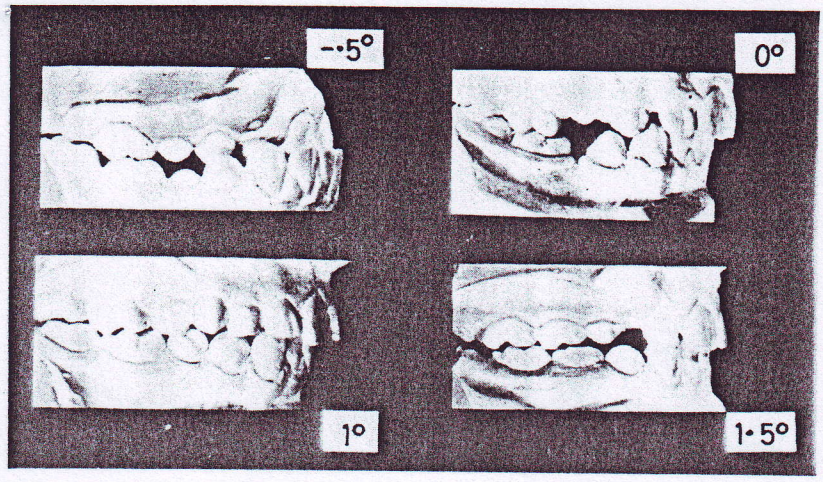

Fig. 5. Family 2. The study models of the children; they are arranged in the same order as the tracings in Fig. 4.

of parents of Group I and II is given for the three possible combinations of parents:

(1) Both parents are skeletal three.
(2) One parent is skeletal three.
(3) Neither parent is skeletal three.

The first and second combinations obviously belong to Group I of the sample and the third combination to Group II.

Among the five families in which both parents are skeletal three there are no less than 13 children who have also a skeletal three apical base relationship.

Of the remaining 13 families of Group I where only one parent is skeletally three there are 3 families with one child, 2 families with 2 children, and 1 with 4 children, who have a skeletal three apical base relationship. The children of the other 7 families all have their angle SNA higher than their angle SNB.

Among the Group II families, 6 of the 18 families have 7 children altogether with a skeletal three apical base relationship, but 12 of the 18 families have all their children with SNA angles higher than their SNB angles.

These results are summarised further in Table 4 which gives for the two groups the percentages of children with a skeletal three apical base relationship. It will be seen that the children of the Group I parents have approximately 100 % greater incidence than the children of Group II.

The Overjets

The labial occlusions of the children were examined and the number of reversed overjets, edge to edge bite and measureable overjets were counted (Table 5).

Measureable overjets were those in which there was a definite space between the labial surface of the lower incisors and the incisal palatal surfaces of the maxillary incisors. These evaluations were made first from the cephalometric radiographs and confirmed on study models wherever they were available. The discrepancy in the number of children in the two groups in Tables 4 and 5 reflects the number of children for whom the overjet picture was not clear on the radiographs and there were no study models on which to make a check.

There were a similar number in both groups with a reversible overjet; but twice as many children had edge to edge labial occlusions in Group I than Group II and there were half as many measureable overjets in Group I than in Group II.

TABLE 1. *The labial occlusions of the parents of groups I and II*

Occlusions	Group I	Group II	Totals
Mandible and Maxilla Complete	8	19	27
Mandible edentulous Maxilla complete	1	0	1
Mandible complete Maxilla edentulous	4	1	5
Mandible and Maxilla edentulous	23	16	39

TABLE 2. *The mean, range and standard deviation of the differences between the angles SNA and SNB for the 50 parents*

	Number	Mean	Range	Standard Deviation
Mothers	50	3.2	— 6° to + 8°	± 2.45
Fathers	50	2.7	— 3° to + 8°	± 2.65

TABLE 3. *The children in groups I and II with skeletal three apical base relationships*

	Children	0	1	2	3	4	Number of children
Group I	Both parents skeletal three (5 families)	0	1	1	2	1	13
	One parent Skeletal three (13 families)	7	3	2	0	1	11
Group II	Neither parent skeletal three (18 families)	12	5	1	0	0	7

TABLE 4. *The incidence on a skeletal three apical base among the children*

	No. of children	Skeletal three apical bases
Group I (18 families)	81	22.3 %
Group II (18 families)	73	10.7 %

TABLE 5. *The incidence of overjets among the children*

	No. of children	Reversed overjets	Edge to edge bites	Measureable overjets
Group I (18 families)	77	5.2 %	5.2 %	43.0 %
Group II (18 families)	67	4.5 %	0.0 %	70.5 %

Discussion

It is recognised that the A and B points defined by Downs, (1948) are not the precise points of demarcation between the basal bone and the alveolar processes, but they do provide a standard means of comparing the antero-posterior relationship of the mandible and maxilla when they are related to the line SN. As an extension to the problem of selecting A and B points as anterior landmarks of the basal bone, there are the unpredictable changes that take place in the bone after the incisor teeth have been extracted. That these changes do take place no one is in serious doubt, but how much they alter the positions of the A and B points does not appear to be exactly known. Thompson (1946) studied 33 patients for whom he took lateral radiographs before and after the extraction of teeth; in the two cases that he illustrates, it is the alveolar process of the mandible which appears to have resorbed more than that of the maxilla. This of course would argue that the A point is more stable than the B point; and so among the edentulous patients of this sample there would be a greater chance of the parents being classified as having a skeletal one or two apical base relationship rather than a skeletal three. Though this may be true it is clearly a matter that needs to be specifically investigated.

Tables 3 and 4 both indicate that there is a 100 % greater chance for the children of Group I parents having a skeletal three apical base relationship; but it does not follow that all the children who have a skeletal three relationship must have parents with the same characteristic. This high percentage among the Group I children is more than twice as large as that reported by Walther (1960), though it should perhaps be remembered that his assessment of the apical base was done clinically and without the aid of cephalometric radiographs.

Table 5 shows the much higher incidence of reversed overjets and edge to edge bites among the children of the Group I parents; the converse of this is true, that 29 % more of the Group II children have measureable overjets.

Though it appears that very little work has been done on the inheritance of the relationship of the mandible to the maxilla, there are numerous studies on the occlusion. Humphreys and Leighton (1950) found that the incidence of post-normal occlusion was always higher in the parents of postnormal children than those in normal children. Asbell (1957) studied the family lines of 10 boys with varying types of occlusion from which he suggested three types of transmission. However, these and other studies emphasise that the occlusion is a result of multiple gene action and is greatly influenced by innumerable environmental factors. Furthermore, the teeth are individual units secured in sockets by fibrous tissue allegedly sustained in place by the balance of muscle forces. The separate bones of the skull, on the other hand, have a much more stable environment, and it is a study of these bones and their relationships to each other that is likely to lead to an understanding of the mechanisms and modes of transmission of the different components of the skull.

SUMMARY

Fifty families with at least four children with the youngest not less than 6 years had lateral cephalometric radiographs and photographs taken. Study models were made for half the sample.

The sample was divided into two groups:

Group I consisted of 18 families in which at least one parent had a negative SNA/SNB value, and

Group II consisted of 18 families in which at least one parent had a 1° to 2.5° difference.

The remainder of the sample was discarded.

The Group I children had a nearly 100 % greater incidence of skeletal three apical base relationship, reversed overjets and edge to edge bites than the children of Group II.

RESUMÉ

On a pris les téléradiographies de profil et les photographies de cinquante familles, chacune comprenait au moins 4 enfants, dont le plus jeune n'avait pas moins de 6 ans. On a fait des modèles en plâtre pour 25 de ces familles.

On a répartis en 2 groupes les familles étudiées, le premier groupe comportant 18 familles où au moins l'un des parents avait une valeur négative pour SNA/SNB; le second groupe comportait 18 familles où l'un des parents, au moins, avait une difference de 1.0° à 2.5°. Les autres familles ont été exclues de l'analyse.

La proportion des individus présentant une relation des bases osseuses de la Classe III, des articules incisifs inversé et des articulés en bout-à-bout était de cent pour cent plus grande chez les enfants du premier groupe que chez ceux du deuxieme.

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DISCUSSION

Dr. LOVIUS asked Dr. BROWN one question – in his Paper he talked about the SNA-SNB differences, but the significance of the differences is in relation to the angles themselves, and as the SNA-SNB angles decrease although one may still get a difference of $+X^0$, the linear relation of points A and B is completely different in relation to the cranial base, and in the assessment of skeletal or dental base relationship. Had Dr. BROWN taken this into account when evaluating the significance of this relation?

Dr. BROWN was not sure that he understood the question; but if the question was why did he employ an SNA-SNB difference to demonstrate the mandible to maxilla relationship, it was because he believed that it was a simple way to demonstrate this relationship.

Professor BIJLSTRA asked: would there not be a change in the A and B points in the cephalograms of the parents who wear full dentures?

Dr. BROWN: Some of the parents were, as was shown in the tracings, edentulous; the use of the A and B points was justified because in the majority of the cases there was a well defined concavity in the mandible and maxilla. The possibility of change of the B point especially in patients wearing dentures was discussed with the prosthetists and they felt that it was unlikely that a change would take place. If there was a change it would result in the B point moving backwards rather than forwards.

Professor BIJLSTRA then asked if Dr BROWN was perfectly sure that people with their own dentitions were less likely to have a pre-normal dental base relationship than people wearing full dentures.

Dr. BROWN replied that of the fifty families, thirty-five had parents of whom at least one was edentulous; and out of that thirty five, there were twenty-three who had a B point anteriorly related to A point.

Dr. VAN DER LINDEN asked if, in the patients wearing full dentures there was not a change in facial appearance which appeared to suggest an increase in prominence of the mandible? Could there not be a degree of closure of vertical dimension which similarly caused an increase in prominence of the mandible? There were three points which could contribute to decrease in the ANB angle in edentulous individuals.

The angle SNA could be influenced by the retraction of the upper incisors. As has been shown frequently changes up to 6 degress could be obtained. Extraction of the upper incisors would probably cause a reduction of the SNA angle.

The same can be true for the point B. The cant of the mandibular plane and the form of the anterior part of the symphysis were of importance here.

The third way was by the decrease in vertical height in the edentulous individual. As the mandible closes the point B is displaced upwards and forwards thus reducing the angle ANB.

Dr. BROWN answered that the lateral skull radiographs for the edentulous patient were taken in the rest position, whilst those for the children were taken with the teeth in occlusion. Radiographs taken in the rest position if anything would have a smaller SNB angle than if they had been taken in occlusion. He, therefore, felt it was legitimate to use the rest position in the edentulous parents. As regards changes in SNB-SNA following loss of incisor teeth, he had no answer.

Professor LUNDSTROM thanked Dr. BROWN for his paper and asked him a question about his family material. He understood that his material was selected from a larger group of families and he would like to know how this selection was done. Secondly, he gave percentages of the cases in Group 1 and Group 2 with the reverse overjet and so on. Would it have been of any advantage to give the mean overjet for the groups and in that way have tested the significance of the findings?

Dr. BROWN commented that from his group of fifty families he chose those families whose parents had a negative SNA-SNB angle. He found there were eighteen families in which one had such an angle. These formed Group 1. He then felt that the best way to obtain a control Group was to select eighteen families with a small positive SNA-SNB difference. He, therefore, took those families in which at lease one parent had an SNA-SNB difference of $+.5$ to $+2.5°$. This now left a residue of twenty-four families from his total group of fifty. In actual fact, there were children in these families with a negative difference and there were two with reverse incisor overjets. But this would not surprise one at all.

He did not calculate the means and correlation co-efficients for the sake of simplicity of presentation.

The PRESIDENT asked if there were any further questions; if not he felt that this 'simplicity of presentation' was a good note on which to finish.