The Relationship Between Lower Incisor Inclination and Various Reference Lines

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The relationship between the inclination of the lower incisors and a number of different skeletal reference lines has been studied[1,5,8,10,19,20] by others. Several authors have tried to exploit this relationship as an aid in clinical diagnosis.[6,9,15,19,20] The connection between the inclination of the lower incisors and the craniofacial type has been assessed in earlier cross-sectional investigations.[1,5-8,10] To elucidate the effect of growth on this relationship, changes in lower incisor inclination over a 3-4 year period have been studied and related to corresponding changes occurring in the reference line NB and the angles ANB and ML/NL.

MATERIAL

The material included in the study consisted of children selected from a control group used previously by Linder-Aronson.[10] The children were inhabitants of Örebro, had no previous history of obstructed nose breathing and were free from upper respiratory tract infection. Consequently, a variety of occlusal types are to be found included in this material. Only children between the ages of 7-12 years were selected. The material examined included registrations carried out on two different occasions, initially and 3-4 years thereafter. Initially, the material consisted of 60 children, 35 males and 25 females. The age distribution is illustrated in Figure 1. The second registration included 30 children, 20 males and 10 females. The other 30 children could not be contacted for the second registration. The age distribution is illustrated in Figure 2.

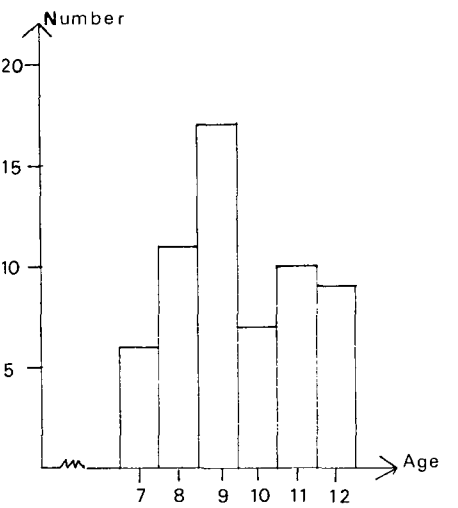

Fig. 1 The age distribution of the initial registration on 60 children.

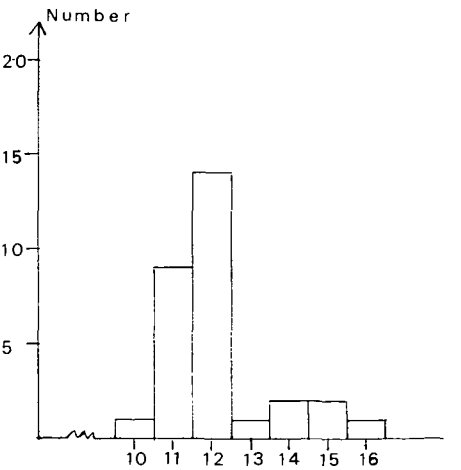

Fig. 2 The age distribution of the second registration, 3-4 years later on 30 children.

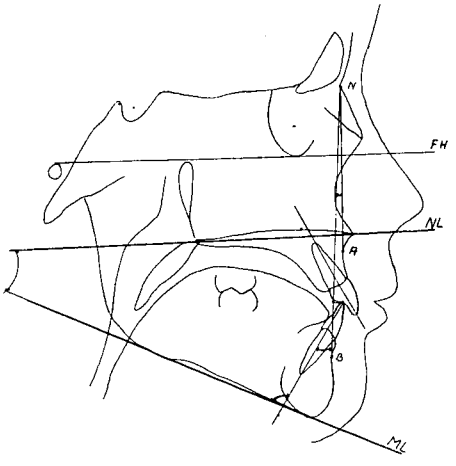

Fig. 3 Cephalometric reference points, reference lines and angles.

Method

Measurements were made from lateral skull cephalograms taken with the patient in centric occlusion and orientated in a cephalostat ad modum Thörne.[18] The film-focus distance was 165 cm giving an enlargement of 7.1% in the median plane.

Reference points, reference lines and angles are illustrated in Figure 3. Angles and distance are defined as:

Ll-NB mm = distance in millimeters from the incisal edge of the lower central incisor measured at right angles to the NB-line.

Ll-NB° = angle between the axial inclination of the lower central incisor and the NB-line.

Ll-ML° = angle between the axial inclination of the lower central incisor and the mandibular line.

ANB° = angle between the NB-line and the NA-line.

ML-NL° = angle between the mandibular line and the nasal line.

The mean and standard deviation were calculated for each variable. These calculations were based initially on 60 cases. In addition, means and standard deviations were calculated for the changes occurring during the period between the first and second registrations. The relationship between the variables was studied using simple correlation analyses.

TABLE I

Error of method

Variable	N	δ	δ^2	S^2_{60}	δ^2 in % of S^2_{60}
Ll-NB mm	20	0.33	0.11	3.3	3.3
Ll-NB°	20	1.11	1.23	33.5	3.7
Ll-ML°	20	1.31	1.72	38.8	4.4
ANB°	20	0.46	0.21	3.1	6.7
ML/NL	20	1.02	1.04	21.0	5.0

The variance of the method error for individual measurement (δ^2) was calculated from 20 randomly selected individuals according to the formula:

$$\delta^2 = \frac{\Sigma\, d^2}{2N}$$

where d is the difference between two measurements and N is the number of double determinations. The method error was expressed as a percentage of the total variance of all the children for each variable, respectively. From Table I it can be seen that the method error range was 3.3-6.7% of the total variance. A large method error was noted for the variables Ll-ML, the ANB angle and the ML/NL angle. This may be due to difficulties in identification of the reference points A and B, gonion, pterygomaxillarae, the anterior nasal spine and the apex of the lower incisor.[13]. The method errors arising out of this study were found to be in good agreement with those reported in earlier investigations.[1,12,21] In the case of variables for which the error variance was greater than 3% of the total variance there is a risk that in simple correlation analyses the size of the true correlation with other variables may be underestimated.

Results

The results illustrated in Table II for the means and standard deviations of the variables expressing the inclination of the lower incisors, the angle ANB, and the angle between the mandibular and nasal lines are consistent

TABLE II

Mean ($\bar{x}$), mean error ($\Sigma \bar{x}$) and standard deviation (SD) for the inclination of the lower incisors Ll-NB°, Ll-NB mm and Ll-ML°, the angle ANB and the angle between the mandibular and nasal lines recorded at the initial registration.

Variable	n	$\bar{x} \pm \Sigma (\bar{x})$	SD
Ll-NB mm	60	3.9 ± 0.23	1.82
Ll-NB°	60	23.1 ± 0.75	5.79
Ll-ML°	60	92.5 ± 0.80	6.22
ANB°	60	3.7 ± 0.23	1.77
ML/NL°	60	26.6 ± 0.59	4.58

with those reported in earlier investigations and may therefore be regarded as normal.

From the histograms shown in Figures 4 and 5 it can be seen that the distribution of the initial values for the inclination of the lower incisors to the ML line and NB line, respectively, was almost normal.

The mean differences obtained following the 3-4 year observation period (Table III) representing changes in the inclination of the lower incisors, the angle ANB, and the angle between the mandibular and nasal lines can be regarded as expected growth modifications for the time interval in question. A "t" test analysis confirmed that the changes in the angles Ll-ML and ML-NL were statistically significant and differed from 0 ($p < 0.001$).

The resulting correlations illustrated in Table IV demonstrate a strongly significant relationship between on the one hand Ll-NB mm and Ll-NB° and on the other hand Ll-ML° ($r = 0.63$ and 0.66, respectively, $p < 0.001$). Furthermore, the size of the angle ANB was found to be strongly correlated to the inclination of the lower incisors regardless of whether the latter was measured in relation to the NB line or the ML line ($p < 0.001$). No significant relationship, however, could be found between the size of the angle ANB and the inclination of the mandibular line to the nasal line.

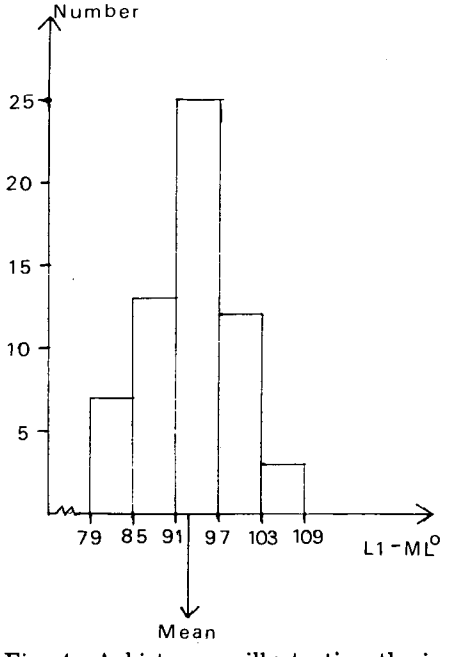

Fig. 4 A histogram illustrating the inclination of the lower incisors to the ML line recorded at the initial registration.

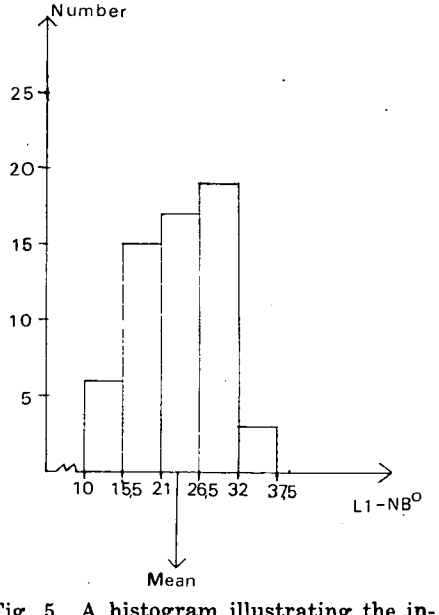

Fig. 5 A histogram illustrating the inclination of the lower incisors to the NB line recorded at the initial registration.

TABLE III

Mean difference ($\bar{d}$), mean error ($\Sigma \bar{d}$) and standard deviation (SD) for changes in the inclination of the lower incisors Ll-NB mm, Ll-NB° and Ll-ML°, the angle ANB and the angle between the mandibular and nasal lines on comparison between the initial and second registration 3-4 years later. The "t" value indicates differences which differ from 0.

Variable	n	$\bar{d} \pm \Sigma (\bar{d})$	SD	t
Ll-NB mm	30	0.5 ± 0.22	1.19	2.36x
Ll-NB°	30	2.0 ± 0.74	4.06	2.66x
Ll-ML°	30	2.7 ± 0.63	3.43	4.39xxx
ANB°	30	—0.5 ± 0.23	1.28	—2.35x
ML/NL°	30	—1.9 ± 0.37	2.02	—5.02xxx

Significant levels:
x = $p < 0.05$
xx = $p < 0.01$
xxx = $p < 0.001$

TABLE IV

Initial correlations, based on 60 children, between lower incisor inclination Ll-NB mm, Ll-NB°, Ll-ML°, the angle ANB and the angle mandibular and nasal lines, ML-NL.

	Ll-NB mm	Ll-NB°	Ll-ML°	ANB°	ML/NL°
Ll-NB mm					
Ll-NB°	0.84xxx				
Ll-ML°	0.63xxx	0.66xxx			
ANB°	0.57xxx	0.54xxx	0.52xxx		
ML/NL°	0.24x	0.04	—0.44xxx	0.20	

TABLE V

Correlations based on 30 children concerning changes noted between the initial and the second registration 3-4 years later for lower incisor inclination Ll-NB mm, Ll-NB°, Ll-ML°, the angle ANB and the angle ML/NL.

	Ll-NB mm	Ll-NB°	Ll-ML°	ANB°	ML/NL°
Ll-NB mm					
Ll-NB°	0.61xx				
Ll-ML°	0.57xx	0.88xxx			
ANB°	0.03	—0.03	0.09		
ML/NL°	0.15	0.04	—0.15	0.04	

Neither was there any significant relationship to be found between Ll-NB° and the angle ML/NL. An almost significant correlation was noted regarding the relationship between Ll-NB mm and the angle ML/NL ($p < 0.05$) and a significant relationship was found between Ll-ML° and the angle ML/NL ($r = -0.44$ $p < 0.01$).

It can be seen from Table V that the changes occurring in the variables Ll-NB mm and Ll-NB° during the 3-4 year observation period were strongly correlated with corresponding changes occurring in the variable Ll-ML° ($r =$ 0.57 and 0.88, respectively). No significant relationship, however, was found between changes occurring in the angle ANB, and changes occurring in lower incisor inclination and the angle ML/NL. Consequently the biological relationship between, on one hand, the variables Ll-NB° and Ll-ML°, and on the other hand, the angle ML/NL, appears to be minimal.

Discussion

The orientation of the lower incisors related to the rest of the facial skeleton has come to play a leading role in the treatment of orthodontic cases. In

Tweed's diagnostic triangle the lower incisors are related to the ML line and the Frankfort horizontal. In Steiner's analysis particular interest is placed in the position of the lower incisors both before and after treatment.

Instead of comparing the position of the lower incisors to norms calculated from a heterogeneous patient material, it is important that diagnosis be individualised and that lower incisor orientation be related to the surrounding structures as seen in each patient.

In this connection special consideration should be taken to changes in lower incisor orientation occurring in conjunction with growth. A number of earlier investigations have studied the relationship between the position of the lower incisors and various craniofacial variables. Only a few articles have been published relating growth changes in lower incisor orientation to corresponding changes in other craniofacial variables.

Of fundamental importance in an analysis of this nature is to try to establish which variables owe their correlationship to a topographical relationship with one another and which variables have a biological interdependence. In this investigation the mean values for the variables studied (see Table II) almost coincide with the accepted norms for these variables.

A comparison between the two registrations reveals a change in the sex distribution. Initially, the material included 60% males and 40% females. On reexamination after 3-4 years the material included 67% males and 33% females. The children examined initially had a mean age of approximately 9 years. The growth changes which occurred during the 3-4 year observation period and illustrated in Table III should therefore not be interpreted without taking into consideration the fact that two-thirds of these registered growth changes occurred in boys.

During the observation period changes in the inclination of the lower incisors to the mandibular line and the mandibular line to the nasal line were found to be significant and to develop in the expected direction. The relationships illustrated in Table IV show that the position of the lower incisors Ll-NB as expressed in millimeters is strongly correlated ($r = 0.84$) to the angle Ll-NB°. This correlation was to be expected considering the topographical relationship between these variables. In clinical diagnosis, therefore, use of only one of these variables ought to be adequate when describing the position of the lower incisors. In such a case the variable Ll-NB mm is to be preferred since changes of this variable also provide information regarding space requirements in the lower arch. This variable, furthermore, shows a strong correlation with the angle Ll-ML. A correlation between lower incisor inclination and the basal jaw relationship (angle ANB) has also been established. The correlation ($r = 0.52$) between the angles Ll-ML° and ANB is of particular interest, as it cannot be explained as being due to a topographical relationship between these variables and is instead seen as expressing a biological interdependence. Similar correlations have been demonstrated by Hasund[5] and Solow.[21] The inclination of the lower incisors may, for example, be increased in compensation for a large basal bone discrepancy between upper and lower jaws.

The inclination of the mandibular line to the nasal line was only found to be significantly correlated with the inclination of the lower incisors to the mandibular line. In this case both variables were topographically related to one another through the reference line ML and can consequently be said to be topographically interdependent.

From Table III it can be seen that during the 3-4 year observation period the only variables to change significantly were the inclination of the lower incisors to the mandibular line and the angle between the mandibular and nasal lines. Of the correlations presented in Table V only those involving the aforementioned variables will be discussed. As expected, strong correlations were obtained between the various variables expressing lower incisor inclination. Of particular interest was the absence of a significant correlation between a change in lower incisor inclination and a change in the inclination of the angle ML/NL. In spite of the topographical relationship described in Table IV between the inclination of the lower incisors to the mandibular line and the angle ML/NL no significant correlation could be found on analysis of the changes occurring in these variables during the observation period. The absence of a significant relationship between these variables can be interpreted as a result of the influence of environmental factors in the form of tongue and lip function on the orientation of the lower incisors.[2,4,10,11]

Summary

The relationship between the inclination of the lower incisors and different cranial reference lines has been studied in a group of 60 children including 35 males and 25 females between the ages of 7-12 years. Following a 3-4 year observation period, 30 of these children were reexamined to study the relationship between changes in the position of the lower incisors and various craniofacial variables brought about by growth. In analysing the results obtained, an attempt was made to distinguish between those relationships which were to a certain extent due to a topographical relationship between the variables involved and those relationships which were of a biological character.

The results obtained from the first registration indicated a strong correlation between Ll-NB mm and Ll-ML° and Ll-NB°. In addition, the connection between lower incisor inclination and the basal bone relationship (ANB°) was found to be strongly significant. The angle ML/NL was found to be correlated only with the inclination of the lower incisors to the mandibular line. Regarding the growth changes occurring during the observation period, no significant correlation could be found between, on the one hand, changes in lower incisor orientation and, on the other hand, changes in the angle ML/NL. The absence of this relationship has been interpreted as being due to the influence of environmental factors in the form of tongue and lip function.

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