The His Line and Ophistion-Nasion Line in Relation to the General Pattern of Craniofacial Associations

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In radiographic cephalometry the use of various reference lines often creates difficulties when comparing the results of different works. This concerns the comparison of the results, reading by reading, and also when considering them as an entity, which is necessary in order to benefit fully from the information that cephalometrics can give.

In modern cephalometric analysis the information should be built around the general pattern of craniofacial associations.[4] This means that if NSL is used as the main reference line, one expects a certain covariation between the variables of the face giving variants from the prognathic through the straight and on to the retrognathic face.[2,3,9,12]

It has been shown by Hasund and Sivertsen[5] that the horizontal facial planes show some variation in relation to NSL. This variation accompanies the general pattern of craniofacial associations, a fact that necessitates the establishing of norms for the prognathic, the straight and the retrognathic face when the individual patient is to be evaluated by cephalometric means in relation to these planes. Both the palatal plane (NL) and the mandibular plane (ML) are defined in relation to reference points in the facial skeleton. The Frankfort horizontal plane (FH) where the posterior reference point *porion* (po) is behind the face also follows the same pattern of inclination as the other horizontal facial planes.

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The His line passes through the points anterior nasal spine (ans) in the facial skeleton and ophistion (oph), the most anterior point on the posterior border of foramen magnum in the sagittal plane (Fig. 1). This line has been used in earlier works,[6,7,13] and has been described as a suitable reference line by Koski and Virolainen.[8] The His line runs a course approximate to the palatal plane (NL) through the facial skeleton. In relation to NL the stability of the His line is dependent on whether the reference point ophistion follows the general pattern of craniofacial associations corresponding to pterygomaxillary fissure (pm), or if there is a compensation, so that measurements in relation to this line can be evaluated independently of the degree of facial inclination and prognathism.

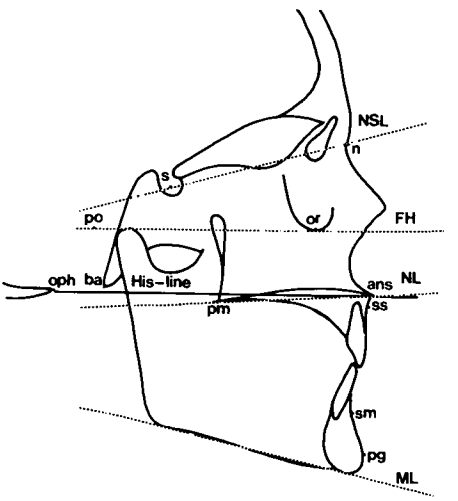

Fig. 1 Reference points and reference lines and planes used in this study.

This relationship also is of direct importance for the use of the ophistion-nasion line (oph-n) as a reference line. This line may be suitable for evaluation of the degree of prognathism in the maxilla by the angle ophistion-nasion-subspinale (o-n-ss). Bergland[1] got different results when comparing groups using ba-n-ss and s-n-ss, respectively, to decide the degree of maxillary prognathism.

The aim of this study is:

1. To consider the His line in relation to the general pattern of craniofacial associations.
2. To determine if the angle ophistion-nasion-subspinale (o-n-ss) can be used to express the degree of maxillary prognathism.

Material and Method

The material consists of 165 Norwegian adults, 72 women and 93 men, and has been previously described.[5] The study is based on cephalometric headplates. All measurements were made independently by two persons and the means of their two measurements were used in the investigation. A limit was put, however, at the point where deviation between two measurements was unacceptable. When the difference of angles 90 degrees or greater was 5 degrees or more, and for angles less than 90 degrees was 3 or more, the measurement of the variable concerned was made by a third person. The mean of the two measurements which thereby came closest to each other was then used.

In addition to previously measured variables, these angles were measured (Fig. 1):

His-NSL: The angle between the line spina nasalis anterior—ophistion and the nasion-sella line.

o-n-ss: The angle ophistion-nasion-subspinale.

Statistical Analyses

The usual statistical parameters were calculated.[10] Besides the linear correlation, variance analyses have been used to get a picture of the covariation between the variables. In a simple variance analysis two and two variables were considered. In studies of the craniofacial relations it is desirable to separate the influence of one or more variables. In this study a multiple analysis was used for this purpose.[11] The group division for the variance analyses is somewhat different for the two sexes, and it does not quite follow the borderlines for prognathism and retrognathism which are the most used anthropological terms in this study, but the deviations are so small that the disadvantages are cancelled by approximately equal sizes of groups. This indicates that in this study the tendency in the material will become apparent, rather than giving the basis for calculation of fixed norms. The group division for the different variables is given in Table I.

Fisher's F-test is used in the variance analysis with the following values: $P=0.05$ for $F=3.12$ for men and $F=3.15$ for women, and $P=0.01$ for $F=4.88$ for men and $F=5.00$ for women.

In the analysis of error, Student's t-test is used to test systematic deviations between measurement and control measurement.

The data were punched and the calculations carried out by the "EDB-Department" at the University of Bergen by cand. mag. Erna Ramm.

Results and Discussion

1. *Analysis of error and the distribution of the material.*

The analysis of error shows no differ-

TABLE I

Group division (I, II, III along the X-axis) for the variables in the variance analysis.

Angle	Sex	Group I	Group II	Group III
s-n-ss	F	72.5 - 79.0	79.1 - 82.0	82.1 - 87.0
	M	74.0 - 81.0	81.1 - 83.8	83.9 - 89.3
o-n-ss	F	61.8 - 65.0	65.1 - 67.9	68.0 - 73.5
	M	60.8 - 66.0	66.1 - 68.8	68.9 - 75.3
s-n-sm	F	71.0 - 77.0	77.1 - 79.4	79.5 - 85.5
	M	72.5 - 77.8	77.9 - 81.2	81.3 - 88.0
s-n-pg	F	72.0 - 78.9	79.0 - 81.4	81.5 - 88.5
	M	74.5 - 79.7	79.8 - 83.2	83.3 - 90.3
n-s-ba	F	119.0 - 128.9	129.0 - 131.9	132.0 - 141.8
	M	119.0 - 127.8	127.9 - 130.8	130.9 - 138.8
NL-NSL	F	0.5 - 6.7	6.8 - 10.0	10.1 - 16.8
	M	1.5 - 6.7	6.8 - 9.5	9.6 - 14.0
ML-NSL	F	15.3 - 29.5	29.6 - 34.9	35.0 - 47.8
	M	13.0 - 26.0	26.1 - 32.0	32.4 - 42.0

ence for the angle NL-NSL and His-NSL (Table II). For o-n-ss the stochastic error is similar to that for s-n-ss. Between the investigators there is a larger stochastic error for His-NSL, but neither for this angle nor for NL-NSL is there systematic deviation between the 1st and 2nd series of measurements. For the two angles of prognathism on the other hand, there is a tendency to systematic deviation ($P < 0.01$). In relation to the stochastic and systematic error, NL shows equal certainty for the individual investigator as for the His line. This is also the case for the two angles of prognathism.

Both o-n-ss and His-NSL show strong conformity with the normal distribution ($\sqrt{b_1}$ and a) in accordance with the other variables in this material.

2. *The material considered in relation to the general pattern of craniofacial associations.*

The material shows harmony between prognathism and the degree of inclination in the upper face (Fig. 2). For women the n-s-ba is somewhat smaller than the degree of prognathism of the maxilla would indicate. For women the n-s-ba must also be considered in relation to disharmony of the mandible between prognathism and inclination.

3. *Variation of the angle His-NSL compared with the angle NL-NSL.*

In this material there is no difference in the mean or the standard deviation between the angle His-NSL and the control angle, but the range for the

TABLE II

The stochastic error (σ) in degrees for the two investigators separately (A, B), and further when the two series of measurements for the two investigators are compared (A/B).

n is the number
$\bar{d}$ the mean for the difference between measurement and control measurement
t is t-value for the test for systematic deviation between 1st and 2nd series of measurements

Investigator	Variable	n	σ	$\bar{d}$	t
A	NL-NSL	30	0.60	−0.25	1.65
	His-NSL	30	0.69	0.08	1.65
	s-n-ss	30	0.48	−0.65	0.39
	o-n-ss	30	1.35	0.73	2.24
B	NL-NSL	30	1.28	0.01	0.04
	His-NSL	30	0.60	0.03	0.21
	s-n-ss	30	1.00	0.48	1.94
	o-n-ss	30	0.83	−0.37	1.78
A/B	NL-NSL	166	1.02	0.09	0.79
	His-NSL	166	3.47	0.44	1.66
	s-n-ss	166	0.94	−0.37	3.69
	o-n-ss	166	0.99	−0.25	2.31

angle NL-NSL is somewhat larger than for the angle His-NSL (Table III). The position and the size of these angles make it possible to compare these data directly.[12] The linear correlation analysis between the two angles gives r= 0.69 for men and r=0.52 for women.

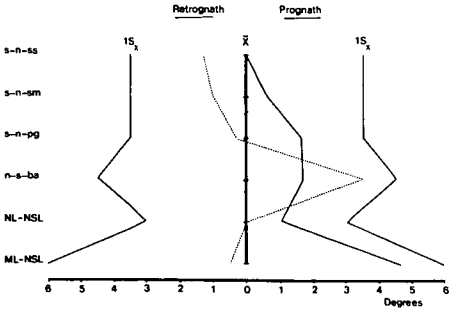

Fig. 2 Wiggle-diagram for testing harmony between prognathism and inclination in the material. The males (——) which are compared with the means from Björk (1947) display a harmonious prognathic tendency. The females (----) compared with the means from Bergland (1963) reveal a deviation from the general pattern of the craniofacial associations.

The angle NL-NSL shows good covariation between prognathism and inclination and the general pattern of the craniofacial associations. There is a greater deviation for men than for women (Table IV, Fig. 3). There is, however, no covariation between the angle NL-NSL and the angle of prognathism o-n-ss.

Figure 4 shows that the His line follows the same pattern of inclination as NL in relation to NSL. This is generally the case for men, with a somewhat deviating tendency for women. This is also confirmed by the F-values in Table IV. On the other hand, there is a greater covariation with n-s-ba for His-NSL than for the control angle. This may be attributed to the close relation-

TABLE III

The mean and the dispersion of the angles His-NSL and NL-NSL.
n is the number
$\bar{x}$ is the arithmetic mean
s is the standard deviation

Variable	Sex	n	$\bar{x}$	s	range
His-NSL	F	72	8.8	2.2	3.3 - 14.3
	M	93	8.5	2.5	3.0 - 14.3
NL-NSL	F	72	8.6	3.1	0.5 - 16.8
	M	93	8.0	2.9	0.8 - 14.0

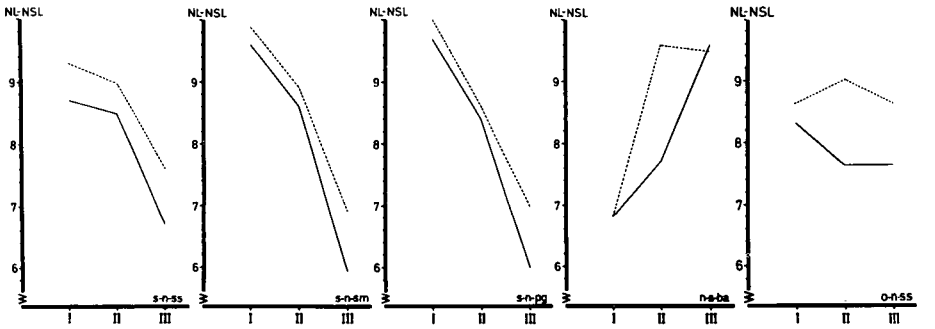

Fig. 3 The angle NL-NSL in relation to the degree of prognathism expressed by the angles s-n-ss, s-n-sm, s-n-pg and o-n-ss, and further in relation to the curve of the cranial base expressed by the angle n-s-ba.

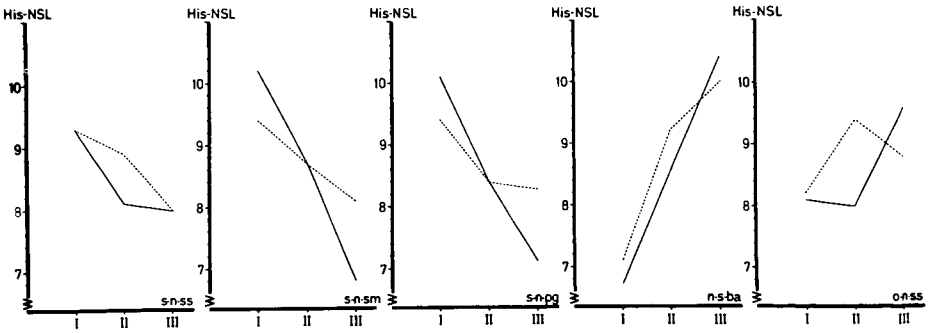

Fig. 4 The angle His-NSL in relation to the degree of prognathism expressed by the angles s-n-ss, s-n-sm, s-n-pg and o-n-ss, and further in relation to the curve of the cranial base, expressed by n-s-ba.

TABLE IV

The F-values from the simple variance analyses where the angles NL-NSL and His-NSL are considered in relation to the prognathism and the curve of the cranial base.

	NL-NSL		His-NSL	
	M	F	M	F
s-n-ss	4.5	2.0	2.8	1.8
o-n-ss	0.4	0.3	3.6	1.9
s-n-sm	17.5	6.5	18.9	1.9
s-n-pg	17.7	6.1	14.2	1.8
n-s-ba	8.0	7.2	26.5	13.4

ship between ophistion and the cranial base.

It has been shown earlier that n-s-ba has a limited value as a basis in classifying the degree of prognathism in this material.[5] When considering the deviating n-s-ba for women, it is reasonable that His-NSL shows little covariation with the degree of prognathism. The pattern for the inclination of the His line in relation to NSL is therefore more complicated than for NL. These two lines accompany each other where there is harmony between prognathism and inclination of the cranial base. In cases of disharmony the angle His-NSL accompanies the curve of the cranial base to a greater degree than the prognathism and departs from the general pattern of the craniofacial associations. The pattern of inclination excludes the use of only one norm for measurements in relation to the His line, but the covariation between n-s-ba and the position of ophistion makes it difficult to calculate these norms.

4. *The degree of prognathism of the upper face expressed by o-n-ss.*

If the means ($\bar{x}$) for men and women are compared, the angle o-n-ss shows the same respective relationship as the angle s-n-ss but with smaller absolute values (Table V). The standard deviation and range is the same for both angles.

It has been shown in Figures 3 and 4 that the variation in the angle o-n-ss is not accompanied by the same inclination of NL and the His line as a corresponding variation of s-n-ss shows. Women do not show a definite statistical connection at all. For men there are deviations for both angles, but in such a way that NL-NSL shows covariation with s-n-ss ($F=4.5$) and His-NSL shows covariation with o-n-ss ($F=3.6$) (Table IV). Figure 5 shows that large o-n-ss angles are accompanied by large s-n-ss angles ($P<0.01$) (Table VI).

The degree of prognathism causes a deviation, but the lack of covariation between o-n-ss and NL-NSL indicates that it is not quite the same individuals in groups I, II and III for the angles s-n-ss and o-n-ss. In group III where the large values of o-n-ss are found, there are individuals where the tend-

TABLE V

Mean and dispersion for the angles o-n-ss and s-n-ss,
n is the number
$\bar{x}$ is the arithmetic mean
s is the standard deviation

Variable	Sex	n	$\bar{x}$	s	range
o-n-ss	F	72	66.5	2.8	61.0 - 73.5
	M	93	67.3	3.0	60.8 - 75.3
s-n-ss	F	72	80.8	3.0	72.5 - 86.5
	M	93	82.1	3.1	74.0 - 89.3

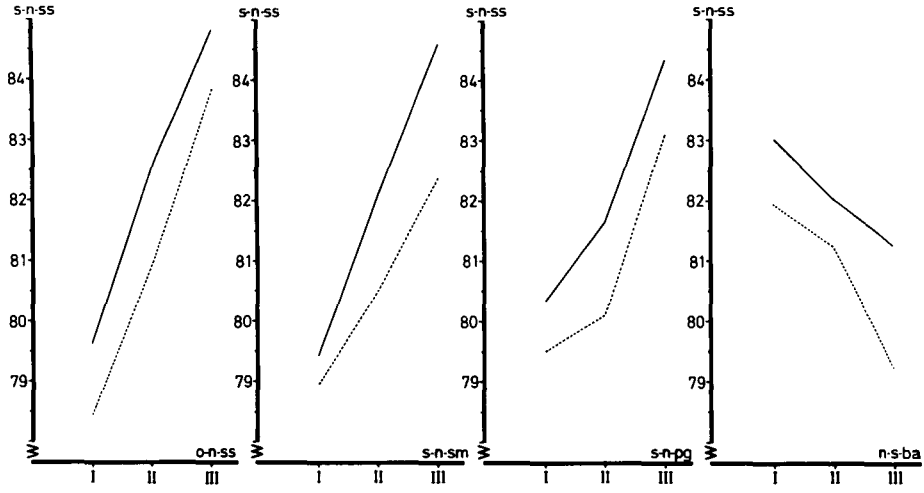

Fig. 5 The angle s-n-ss in relation to the angles of prognathism o-n-ss, s-n-sm and s-n-pg, and further in relation to the curve of the cranial base expressed by the angle n-s-ba.

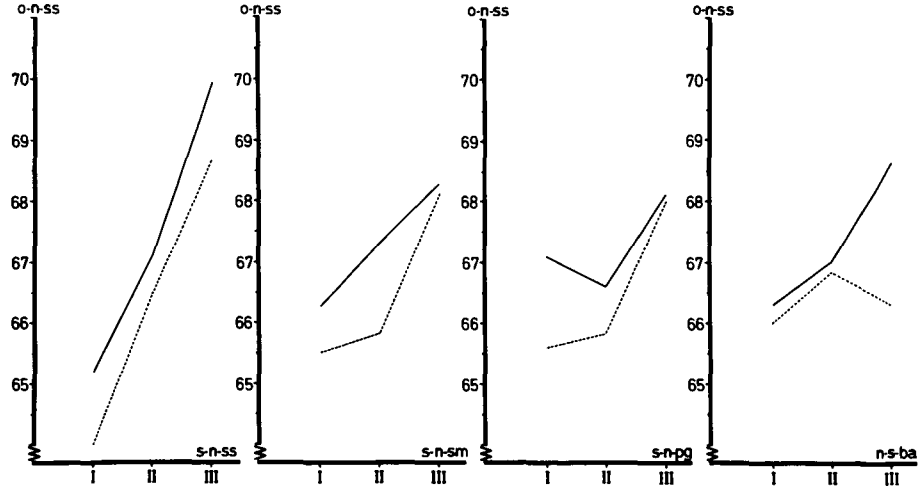

Fig. 6 The angle o-n-ss in relation to the angles of prognathism s-n-ss, s-n-sm, s-n-pg, and further in relation to the curve of the cranial base expressed by the angle n-s-ba.

TABLE VI

F-values for the individual variance analysis where the angles o-n-ss and s-n-ss are regarded in relation to mandibular prognathism and the curve of the cranial base.

	o-n-ss		s-n-ss	
	M	F	M	F
s-n-ss	35.1	35.1	—	—
o-n-ss	—	—	38.7	36.5
s-n-sm	3.6	7.0	36.8	18.6
s-n-pg	2.3	5.9	17.6	12.3
n-s-ba	4.2	0.5	2.5	6.0

ency to disharmony is stronger than in group III for the angle s-n-ss.

The two angles of prognathism show different covariation with the degree of prognathism of the lower face (s-n-sm and s-n-pg) with clearly less correlation for the angle o-n-ss than for the angle s-n-ss (Figs. 5 and 6) (Table VI).

The great difference between the two angles of prognathism appears in relation to the curve of the cranial base (n-s-ba). The covariation between the angle n-s-ba and the angle s-n-ss follows the general pattern of craniofacial associations where large n-s-ba angles are accompanied by small s-n-ss angles (for women $P < 0.01$). Men show the same tendency, but there is no significant deviation. The angle o-n-ss stands out clearly, though. For women there is no covariation. For men large n-s-ba angles are accompanied by large o-n-ss angles. This can be seen in relation to the close connection between the position of ophistion and the variation of n-s-ba.

The variation of the angle o-n-ss may therefore be considered in relation to changes both for subspinale and ophistion. If prognathism is defined as the sagittal position of subspinale in relation to the anterior cranial fossa, the angle s-n-ss is a better expression for the degree of prognathism than the angle o-n-ss since the sella-point is a more stable point in this connection than ophistion which varies with the angle n-s-ba.

Conclusions

1. The His line passes approximately through the same area of the facial skeleton as NL. Neither in relation to the error of method nor in relation to the norms of different types of faces does the His line show any advantage. In its strong covariation with n-s-ba the His line brings in uncertainty which makes NL preferable as a reference line.
2. In the same way as for the His line, the stability of the nasion-ophistion line is influenced by the change of position of ophistion in relation to variation of the angle n-s-ba. The angle ophistion-nasion-subspinale (o-n-ss) is therefore of little use as an expression of the sagittal position of subspinale.

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