Rotational effects of S-N on the dentoskeletal pattern within the range of normal

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In cephalometric radiographic analysis, the sella-nasion line (S-N) is commonly used to represent the anterior cranial base and serve as a reference to describe relative skeletal relationships among the maxilla, mandible, and the base of the skull. While S-N is considered by many to be a more stable and reliable reference than the Frankfort plane,[1-3] others[4,5] have concluded that the Frankfort horizontal plane is a more reliable reference.

The stability of S-N as a reliable reference in lateral skull radiographic analysis has also been the subject of many studies.[2,3,6,7] While the clinician can simply depend on a reference system other than S-N, the presence of sella and nasion cannot be ignored, as they are involved in many cephalometric parameters.

Mills[4] has demonstrated that the significance of the angle A-N-B varies according to the size of the angle S-N-A, which in turn is affected by the length and cant of S-N and the relative upward or downward relation of nasion. He suggested corrective methods to adjust angles S-N-A and A-N-B by moving points nasion and sella until he achieved the "correct" values of the angles.

Bishara et al.[9] demonstrated that the spatial variability of the points S and N are determinant factors in the relative rotation of S-N.

Jarvinen[10-12] has shown that the possible differences in recorded values of the angle S-N-A are partly ascribed to the true variability in the antero-posterior location of the maxilla, whereas another part can be explained by differences in shape of the cranial base as represented by S-N.

Casko and Shepard[13] examined 79 Caucasian adults with ideal occlusion in a study to evaluate the range of variation in various dental and skeletal parameters. Their study demonstrated a wide range of variation in different parameters, with an interesting pattern of dental and skeletal compensation to maintain normality.

Established cephalometric norms limit the clinician to a range of normality within the major-

Abstract
The range of orientation of SN in relation to the craniofacial centroid line in a Class I sample with "acceptable" profiles is divided into three groups for comparison with facial dentoskeletal structures and evaluation of the adaptations among them. This manuscript was originally submitted September, 1986.

Key Words
Centroid • Cephalometrics

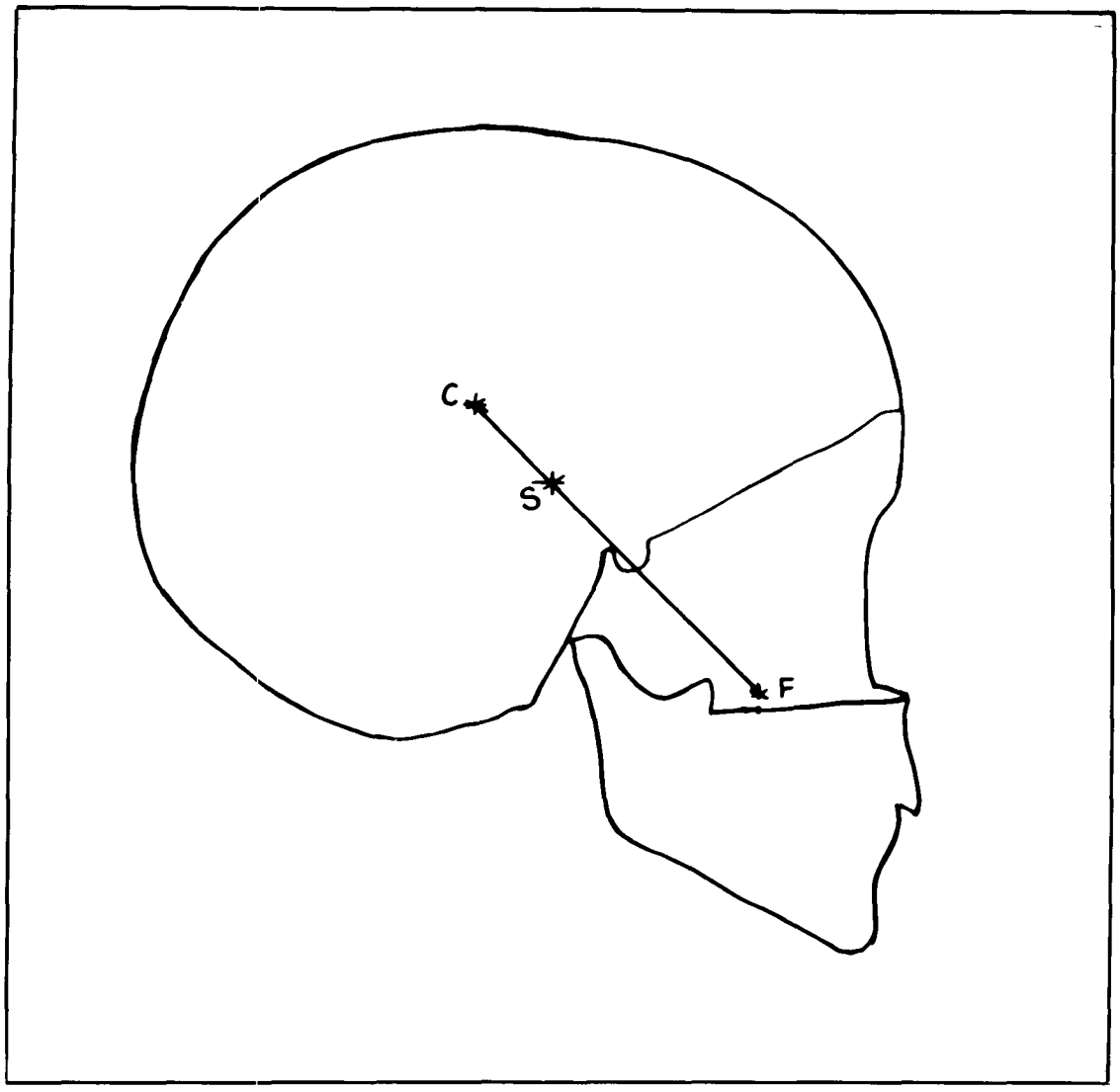

Figure 1
Craniofacial centroid line (CFC). C = center of cranium; F = center of face; S = center of skull

ity of cases examined. However, in some instances one should consider the possible variations in the craniofacial system which could bring about unusual parameters for clinically normal class I patients.

Johnson[2,13] asserts through accumulation of statistical, logical and circumstantial evidence that the central area of the tracing of a lateral skull radiograph appears to be its least variable point, while its least variable line is that connecting the centers of the cranium, skull and face termed the craniofacial centroid line (CFC) (Fig. 1). He demonstrates that the Frankfort plane appears to be more variable and therefore less stable than sella-nasion, maxillary plane, or mandibular plane.

The aim of the present study is to identify the orientation of the sella-nasion line in relation to the skull outline as measured against the craniofacial centroid line,[2] and determine the possible dentoskeletal adaptations as a result of the sella-nasion orientation for patients with clinically normal profile and occlusion. The sample is divided into three groups according to S-N-A values, so comparisons between the same parameters can be readily assessed (Table 1).

Materials and Methods

The sample is comprised of 49 Caucasian adult Saudi Arabians. All had normal Class I occlusion and clinically acceptable profiles. Lateral skull radiographs were taken, and the sample then broken down according to the values of S-N-A (Table 1).

The lateral skull radiographs were traced and digitized using a microcomputer. The computer was programmed to produce the centroids of the skull, cranium and face to locate the craniofacial centroid line (Fig. 1). Ten of the most popular skeletal and dental cephalometric measurements were also applied (Table 2).

The mean, standard deviation, maximum, minimum and median values were determined for each of the three groups of S-N-A values and analysis of variance applied between pairs. Cor-

relation coeffecients were calculated among all of the 10 parameters.

Results

Mean, standard deviation, maximum, minimum and median values are listed in Tables 2-4.

Analyses of variance among the three groups of S-N-A values are listed in Table 5. The correlation coeffecients for each S-N-A group is listed in Table 6.

Angle S-N/A-B varied along a range of 15° with a maximum of 79° and minimum of 64°. The S-N/mandibular plane angle ranged from 43° to 26°, while the palatal plane/mandibular plane angle ranged within 21° (Maximum 39°, minimum 18°). The maximum value of the angle S-N/palatal plane was 15°, while the minimum was 2°.

The relative position of sella-nasion on the skull as measured against the cranio-facial centroid line ranged from 130° to 112°. The analysis of variance among the three groups revealed significant differences between parameters for patients with a normal occlusion and profile (Table 5).

An interesting fashion of skeletal and dental adaptation was revealed by correlations of parameters within each group (Table 6).

Correlation coeffecients among the groups of S-N-A values revealed common parameters highly correlated with each other. Parameters which correlated highly in different S-N-A groups and did not correlate in other groups are probably responsible for the dentoskeletal adaptation. These parameters are listed in Table 6.

Discussion

The objective of this study is to detect the rotational position of S-N as measured against the craniofacial centroid line and observe the different compensatory adaptations to produce normal occlusion and profile. The craniofacial centroid line is postulated by Johnson[2] to be a more stable reference line in relation to other anatomical or derived mathematical lines.

The position of S-N line in relation to the skull outline as measured against the CFC line (Tables 2-4) reveals a progressive order for S-N angle for S-N-A values between 71.5° and 75°. The mean orientation of the S-N line is 119°, while for S-N-A values between 76° and 80° and 81°-87° the mean orientations for S-N line were 121.8° and 126.4° respectively. This confirms Mills[8] that an anticlockwise rotation of the S-N line would decrease S-N-A angle while a clockwise rotation would increase the S-N-A angle.

The mean value for S-N-A angle for the three groups was 83°, which is within the range of

Table 1

	SNA 71.5°-75°	SNA 76°-80°	SNA 81°-86°
Number of Patients	14	19	16

Table 2

Means, Standard Deviation, Maximum-Minimum Values and Median for SNA Group 71.5°-75°

Parameters	Means	S.D.	Max.	Min.	Median
ANB	1.77	0.64	3.00	1.00	1.77
SN-AB	69.23	3.95	76.50	64.00	69.00
SN-(Go, Me) Mand. Plane	41.95	4.86	47.50	32.00	42.50
ANS, PNS-Go, Me	32.59	3.90	39.00	25.50	33.00
SN-ANS, PNS	9.04	3.89	15.00	2.50	9.50
$\underline{1}$-SN	97.36	3.66	101.00	90.00	98.00
$\overline{1}$-Go, Me	85.64	9.07	106.00	74.00	83.50
Gonial Angle	135.20	7.60	149.00	124.50	134.00
SNA	73.73	1.31	75.00	71.50	74.00
SNB	71.91	1.61	74.00	69.00	72.00
SN-CFC (Cranio-facial centroid line)	119.00	4.10	125.00	112.00	119.00

Number of subjects = 14

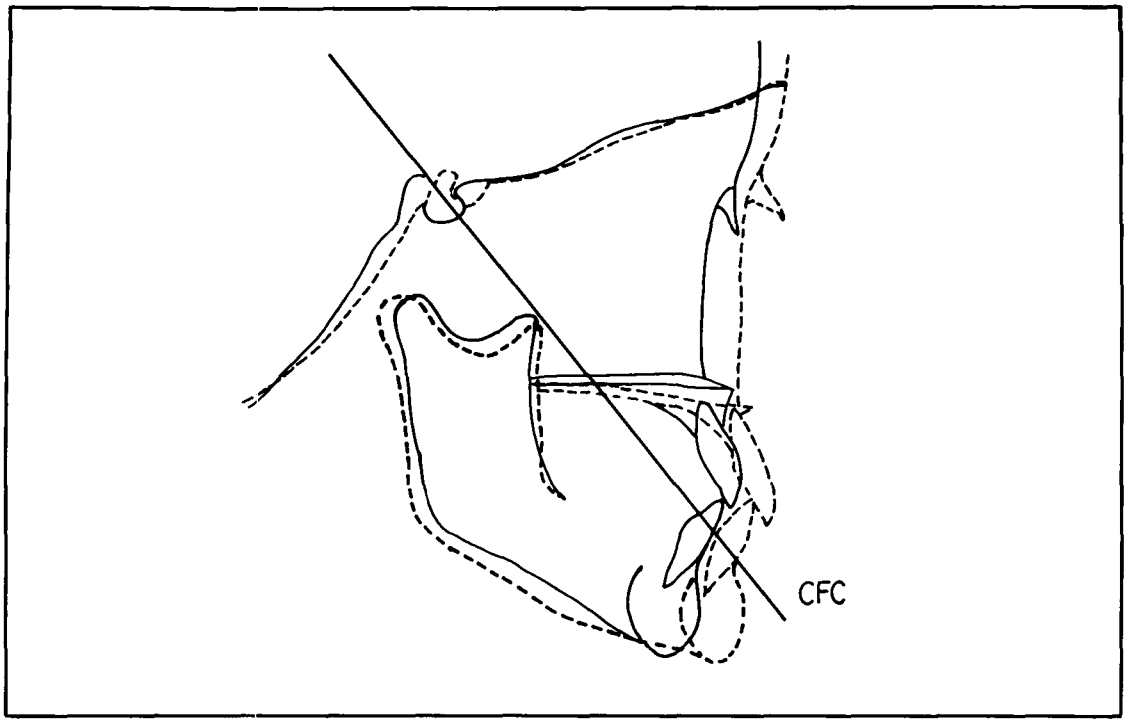

Figure 2
Superimposition on the craniofacial centroid line CFC with high (4°, solid line) and low (1°, broken line) ANB values.

Table 3

Means, Standard Deviation, Maximum-Minimum Values and Median for SNA Group 76°-80°

Parameters	Means	S.D.	Max.	Min.	Median
ANB	2.43	0.62	3.50	1.50	2.50
SN-A,B	70.38	2.53	73.50	66.50	70.00
SN-(Go, Me)	35.19	5.07	43.00	29.00	35.19
ANS, PNS-Go, Me	25.50	4.75	32.00	18.00	25.75
SN-ANS, PNS	9.31	3.03	13.00	2.50	10.00
$\underline{1}$-SN	97.44	4.77	105.00	92.00	97.00
$\overline{1}$-Go, Me	90.75	5.42	98.00	82.00	91.00
Gonial Angle	128.60	3.90	135.00	124.00	128.00
SNA	77.56	1.05	79.00	76.00	77.25
SNB	75.13	0.99	76.50	74.00	75.00
SN-CFC (Cranio-facial centroid line)	121.80	2.10	125.00	119.00	122.25

Number of subjects = 19

other studies.[2,3,14] However, the samples used in the above studies were randomly selected, yet the S-N-A values could compare with the present study which is a selected sample based on normality.

Figures 2-4 compare the extreme values for the cephalometric tracings of the statistically significant parameters among the three groups (Table 5). The significant differences between the groups were recorded for angles A-N-B, S-N/A-B, S-N/Go-Gn, palatal plane/mandibular plane, S-N-B, and S-N/CFC.

The superimposition of the extreme values would show a large margin of variation between patients having normal skeletal relation and occlusion. Casko and Shepard[13] observed a wide range of variation between subjects with normal occlusion and acceptable profiles. However, they demonstrated the differences in lateral shapes by superimposing the tracings on the S-N line, which in turn is quite a variable reference line.

The breaking down of the sample by values for S-N-A angle enabled the study to cluster each group of normals and observe the dentoskeletal adaptation taking place in the same group.

In the light of the results (Table 2) it will be observed that the mean S-N orientation to the CFC line is 119°, which indicates an anticlockwise displacement for S-N in relation to the skull. In this group of S-N-A values (71.5°-75°), high negative correlations between angles A-N-B and the angles S-N/A-B and S-N-B confirms the effect of the anticlockwise displacement of S-N;

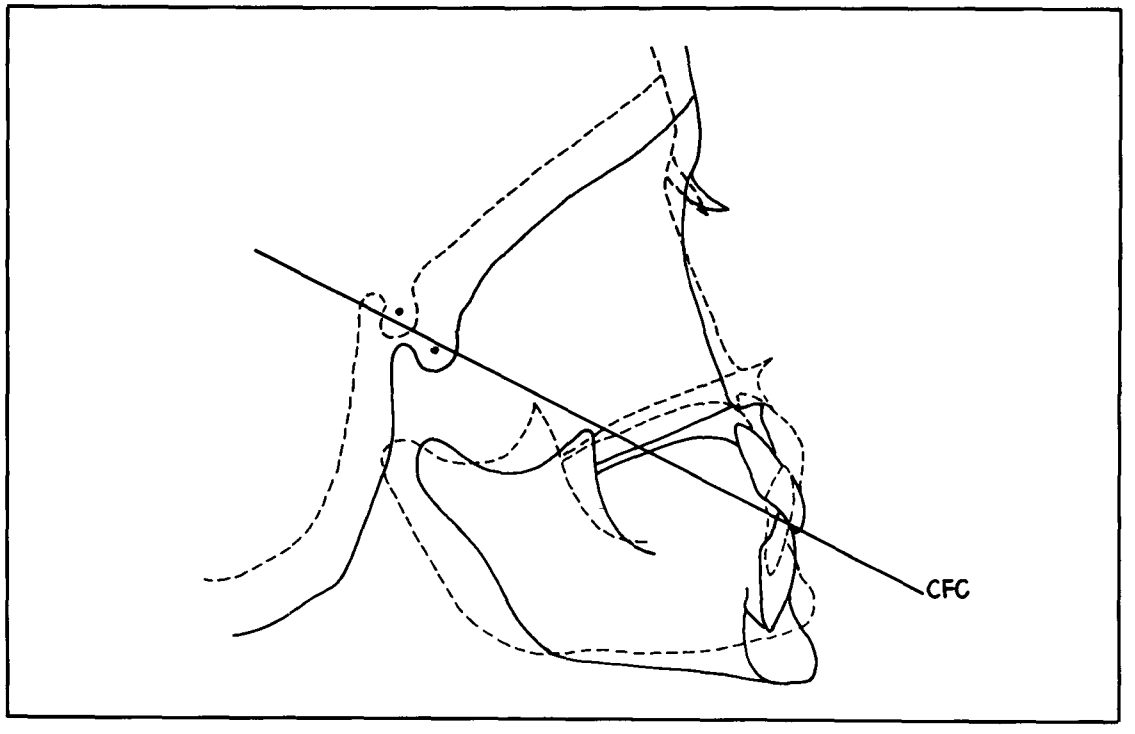

Figure 3
Superimposition on the craniofacial centroid line CFC with high (47°, solid line) and low (26°, broken line) SN - Mandibular plane angles.

a negative correlation between angle A-N-B and angles S-N/palatal plane and S-N-B, which confirms Mills[8].

A negative correlation was also found between the angle S-N/palatal plane and incisor/mandibular plane, and a positive correlation between incisor/S-N and incisor/mandibular plane.

For values of S-N-A in the 81°-87° group the mean S-N orientation to the CFC is 126.4° (Table 4), showing a clockwise displacement. This group shows a negative correlation between palatal plane/mandibular plane angle and the S-N/palatal plane angle.

The information obtained in this study can be helpful in many ways. First, the ability to superimpose the lateral shapes on the CFC line enables the clinician to accurately assess the skeletal relations. Second, the rough estimate of the extremes in skeletal variation which is provided clearly demonstrates the dental adaptations taking place. These cases would not always require orthognathic surgery, but would need a more detailed examination.

Analysis of variance findings (Table 5) show significant differences between parameters of three groups of S-N-A values, indicating that treatment planning should be based on a range of the mean in growing patients.

Summary

Lateral cephalometric radiographs of 49 adult patients with normal occlusion and acceptable profiles are evaluated.

The sample was divided into three groups

Table 4

Means, Standard Deviation, Maximum-Minimum Values and Median for SNA Group 81°-87°

Parameters	Means	S.D.	Max.	Min.	Median
ANB	2.83	0.86	4.00	1.00	3.00
SN-AB	75.44	2.88	79.00	72.00	74.00
SN-(Go, Me)	31.67	4.13	39.00	26.00	31.50
ANS, PNS-Go, Me	27.00	6.30	38.00	18.00	28.00
SN-ANS, PNS	5.44	2.74	10.00	2.00	5.00
$\bar{1}$-SN	101.72	3.93	107.00	95.00	103.00
$\bar{1}$-Go, Me	91.56	6.97	101.00	83.00	93.00
Gonial Angle	129.40	5.20	138.00	121.00	129.00
SNA	83.33	2.45	87.00	80.00	83.00
SNB	80.44	2.36	84.00	77.00	79.50
SN-CFC (Cranio-facial centroid line)	126.40	2.50	130.00	124.00	125.00

Number of subjects = 16

Figure 4
Superimposition on the craniofacial centroid line. Solid line SNA = 87°; broken line SNA = 71.5°.

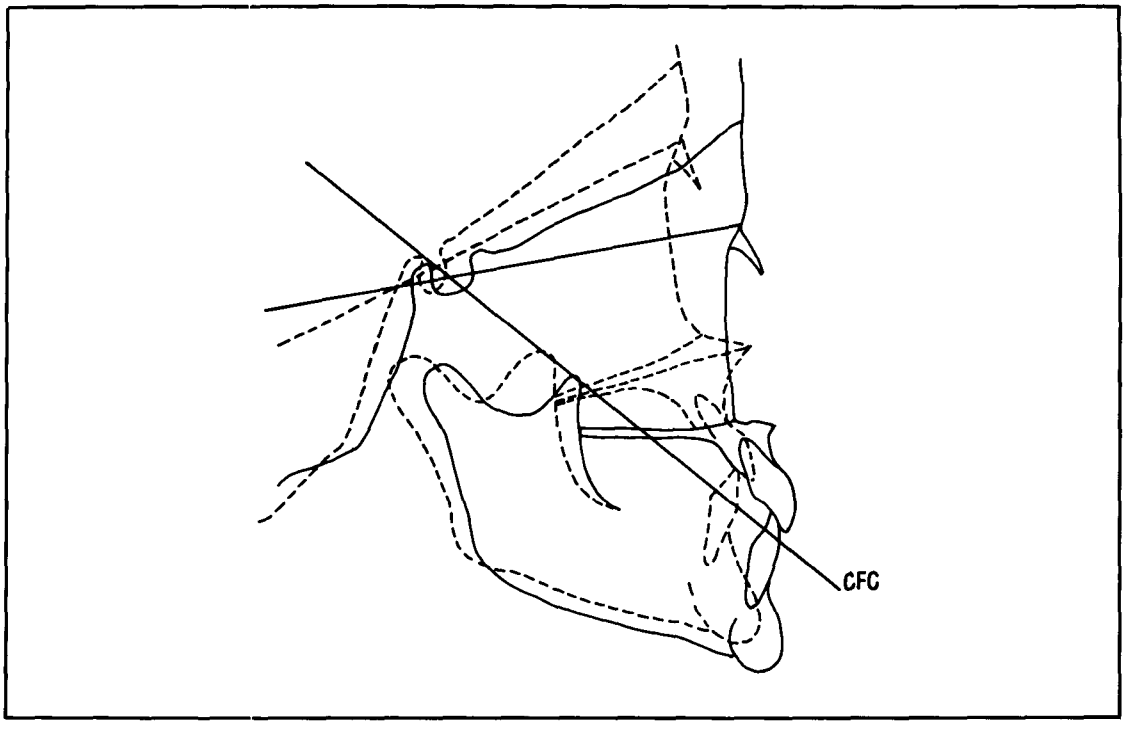

Table 5

Analysis of variance between the three groups of SNA values.

PARAMETERS	F VALUE
ANB	5.59*
SN-AB	9.69*
SN-Go, Me	12.45*
ANS, PNS-Go, Me	5.46*
SN-ANS, PNS	N.S
$\underline{1}$-SN	N.S
$\overline{1}$-Go, Me	N.S
Gonial Angle	N.S
SNA	78.55**
SNB	57.05**
SN-CFC (Cranio-facial centroid line)	14.01*

P value < *0.05, **0.01

Table 6

Positive and negative correlation coefficient at P<0.001 for SNA at the three groups.

(A) SNA group 71.5°-75°

SNA

+ve	-ve
S,N-A,B	ANB
$\underline{1}$ - SN	SN-palatal plane

(B) SNA group 76°-80°

SNA

+ve	-ve
ANB	SN-palatal plane
	$\underline{1}$ - SN

(C) SNA group 81°-87°

SNA

+ve	-ve
SN-AB	$\overline{1}$-mandibular plane
Gonial Angle	

according to the values of angle S-N-A. Ten cephalometric measurements were recorded and statistically analysed for each group (mean, standard deviation, maximum, minimum, and median).

The orientation of S-N is recorded against the craniofacial centroid line. Correlation coefficients are used to identify dental and skeletal adaptations associated with these variations.

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