A new cephalometric parameter to aid in dental base relationship analysis

By O.A. Sarhan, BDS, PhD

In assessing the relation of the anterior border of the maxilla (as is measured in angle ANB), the nasion has been used for many years as a suitable point from which to measure the angle. However, it is recognized that the position of the nasion can vary; for example if the frontal sinus is large, the nasion is displaced forward,[1] which will serve to reduce angle ANB. However, there has been little quantitative research to verify this.

In this respect, Freeman[2] emphasized the importance of considering the antero-posterior relation of point 'A' to the cranium as represented by point 'Na.'

The assessment of the basal relationship through angle ANB was introduced by Riedel.[3] It was immediately adopted as an important clinical aid and has been included in most cephalometric analyses due to its ease and rapidity of application. Dreyer and Joffe[4] critically studied Downs analysis during which nasion is used three times as a landmark and found that its position is affected by migration of the fronto-nasal suture during growth. Moore[5] observed that both nasion and pterygomaxillary fissure, once thought to be relatively stable in all individuals, are actually highly variable during growth in some individuals.

Taylor[6] found that angle ANB is not always a true indication of the dental base relationship and that the angle varies according to facial divergence. For example, SNA values of 80° or greater were found to have the largest average ANB value, and those with an angle measuring 77° or less had the smallest.

Jacobson[7] confirming Taylor[6] showed that angle ANB may present apparent anomalies in the diagnosis of Class I and Class II tendencies due to length of cranial base or rotational effects of the jaws relative to the sella-nasion plane. He, therefore, suggested direct reference from point A and point B to the occlusal plane for assessing the dental base relationship. Sarhan[8] showed that while the Wits analysis was a reli-

Abstract

The cephalometric literature is rich with different craniofacial analyses. However, since these analyses are only descriptive for the clear skeletal discrepancies and somewhat handicapped for borderline cases, an investigation was designed to assess the dental base relationship in the human lateral skull cephalostat radiograph. A number of existing measurements were reviewed, and a new measurement, based upon anatomical points which could prove to be more reliable, was introduced.

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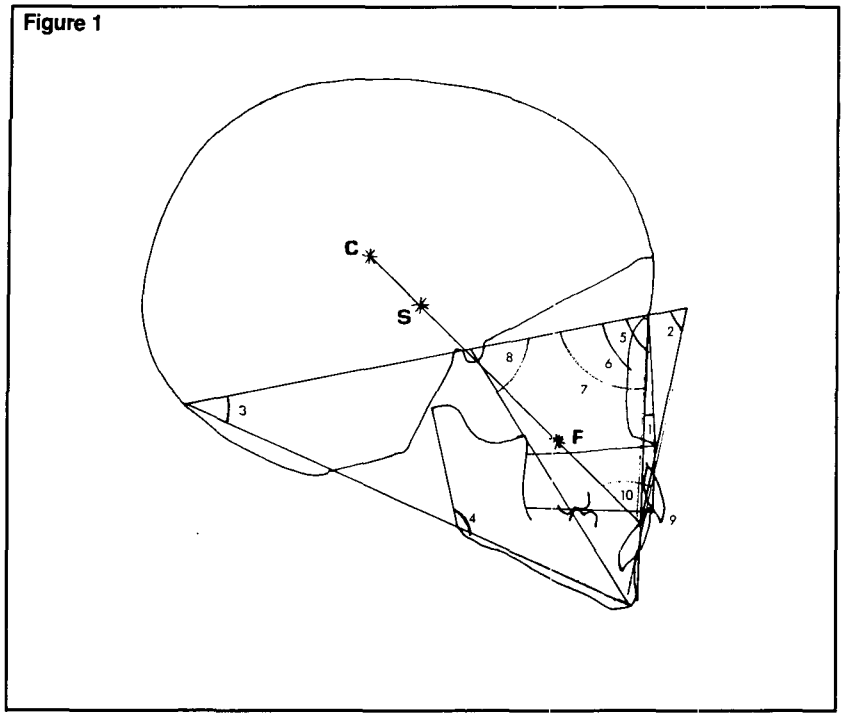
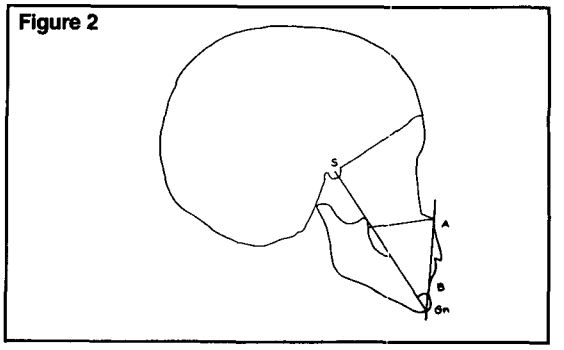
Key Words

Cephalometric analysis • Dental base analysis • Centroid analysis





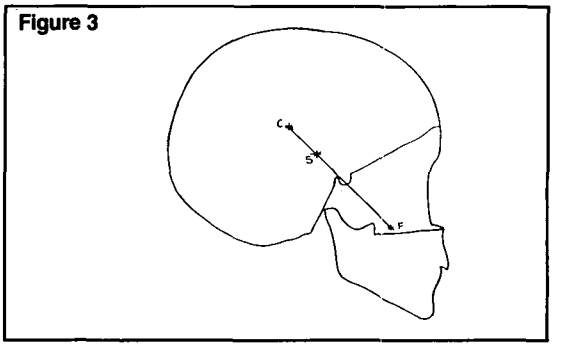


Figure 1
Measurements used in this study.

Figure 2
Sella Gnathion; Dental Base S Gn; AB

Figure 3
Cranio-facial centroid line.

able assessor of the dental base relationship in an antero-posterior position, on upper facial and mandibular rotations, it did not show any descriptive measures.

Hitchcock[9] found that angles SNA and SNB do not clearly separate Class II division 2 malocclusion from normal occlusion. Casko and Shepard[10] demonstrated a wide range of angles ANB and SNA for adults acquiring normal occlusion and skeletal balance. In fact, this wide range of variability is explained by Bishara[11] and Jarvinen[12,13] and Sarhan.[14] Spatial variability of the points S and N are determinant factors in the relative rotation of SN. Mills[15] suggested adjustments for values of SNA angle to correct the nasion position.

Johnson,[1] criticized the conventional tracings for dental base assessment and introduced a dental base analysis which is based on mathematical centers of gravity. This parameter could be applied either manually using cardboard cuts or by using a computer program. Basically, this dental base angle was formed between a line passing through the centers of skull, cranium and face (c-f-c) and the line joining the A-B points.

From the above, it seems that workers in the field were not satisfied with dental base analysis probably because of anatomical unreliability, overlaps and similarities between individuals or the impracticality of the measurements.

Therefore, the intent of this study is to test some of the popular dental base analyses and their sensitivity to different skeletal discrepancies and also to introduce and compare a new parameter which could be useful in assessing the dental base relationship.

Hypothesis

It seemed logical to try and investigate sensitivity of existing parameters in the literature against other new parameters in assessing the dental base relationship. Also, in selecting or formulating any cephalometric parameter, one should consider using relatively stable structures.

The anterior cranial base (SN) is somewhat stable with very minimal change after the age of six years, De Coster.[16] Also, Björk and associates[17] suggested that structures of the chin point are also relatively stable.

From the above, a new cephalometric angle based on the sella turcica structure and a relatively stable chin point (Gnathion) when measured against Subspinale (A) and Supra-mentale (B), would be a suitable candidate for assessing the relative retrusion or protrusions of both jaws.

Therefore, angle Sella Gnathion, A, B would be tested against several parameters applied to a sample representing different malocclusions which could show a degree of sensitivity in identifying the different malocclusion classes.

Materials and methods

Selection of the sample

Seventy Saudi Arabian adults were selected for this study; none of the subjects had had any orthodontic treatment. The sample was collected

by selecting 28 subjects acquiring Class I normal occlusion and balanced profiles, 23 subjects with Class II skeletal and molar classifications, and 19 subjects acquiring Class III skeletal and molar classifications.

Collecting the data

Lateral skull cephalostat radiographs were taken on the 70 subjects in a routine manner to include the outline of the skull using 10x12-inch film. Each radiograph was traced to include the skull periphery and cranial base.

Measurements used in this study

1 — ANB
Subspinale; Nasion; Supramentale
2 — SN; AB
Sella Nasion Plane; dental base
3 — SN; Go Gn
Sella Nasion Plane; mandibular plane
4 — Co Go; Go Gn
Condilyon, Gonion (Ramal); Gonion, Gnathion (Gonial angle)
5 — SNA
Sella; Nasion; Subspinale
6 — SNB
Sella; Nasion; Supramentale
7 — SNPog
Sella; Nasion; Pog
8 — N; S Gn
Nasion; Sella, Gnathion
9 — Ao-Bo
Wits Analysis
10 — *Centroid, dental base angle
CFC — A,B
11 — SGn; AB — Fig. 1
Sella Gnathion; dental base angle
C=Center of cranium
F=Center of face
S=Center of total skull (face + cranium)

Locating the craniofacial centroid line CFC

The 70 tracings were retraced again with an Apple IIe enhanced machine using programs Ortho 1 and Ortho 2. The programs were obtained by personal communications from the Department of Orthodontics at Manchester University, England.

Basically, the craniofacial centroid line, CFC, Fig. 3, is a line joining the centers of the total skull, face and cranium.

Statistical tests used

The data of this study was subjected to descriptive tests, mean, standard deviation, range, maximum and minimum values and correlation co-efficient for each group. Analysis of variance (ANoVA) was performed among the three groups.

Table 1
Descriptive statistics for parameters of Class I patients

Parameter	Mean	S D	Minimum	Maximum	N
A N B	2.54	1.24	0.000	5.00	28
SN, AB	72.85	4.26	66.50	82.50	28
SN, Go Gn	36.44	4.91	28.00	44.50	28
CoGo, Go Gn Gonial	129.92	4.74	123.00	140.00	28
S N A	80.50	4.03	72.50	91.00	28
S N B	77.96	4.22	71.00	90.00	28
S N Pog	78.62	4.37	71.00	92.00	28
NS, S Gn	70.37	4.51	57.00	76.00	28
Ao-Bo (Wits)	-0.01	0.22	-0.30	0.60	28
Centroid dental base (CFC-AB)	49.70	2.82	44.00	56.00	28
S Gn, AB	35.46	2.13	30.00	38.00	28

Table 2
Descriptive statistics for parameters of Class II patients

Parameter	Mean	S D	Minimum	Maximum	N
A N B	5.73	1.41	2.00	8.00	23
SN, AB	66.08	3.79	59.50	73.50	23
SN, Go Gn	37.00	5.25	27.00	47.00	23
CoGo, Gonial	129.04	5.59	120.00	140.00	23
S N A	80.95	2.93	75.00	87.00	23
S N B	75.30	3.02	71.00	81.50	23
S N Pog	74.04	11.24	24.00	81.00	23
NS, S Gn	70.80	4.53	55.00	77.00	23
Ao-Bo (Wits)	0.40	0.26	-0.20	1.20	23
Centroid dental base (CFC-AB)	55.96	3.46	49.00	61.00	23
S Gn, AB	43.13	4.25	39.00	54.00	23

Table 3
Descriptive statistics for parameters for Class III patients

Parameter	Mean	S D	Minimum	Maximum	N
A N B	0.28	1.72	-3.00	4.00	19
SN, AB	78.78	4.34	71.50	86.00	19
SN, Go Gn	36.00	5.88	27.00	49.00	19
CoGo, Gonial	132.92	5.72	125.00	149.00	19
S N A	79.68	3.61	73.00	88.00	19
S N B	79.48	3.22	74.00	84.50	19
S N Pog	80.63	3.36	75.00	86.00	19
NS, S Gn	67.94	3.60	59.50	75.00	19
Ao-Bo (Wits)	-0.37	0.26	-0.75	0.15	19
Centroid dental base (CFC-AB)	43.97	3.83	37.50	50.50	19
S Gn, AB	31.31	1.91	26.00	30.00	19

Table 4
Analysis of variance applied to the cephalometric parameters

Parameters	F
A N B	76.32*
SN, AB	49.51*
SN, Go Gn	0.19
CoGo, Go Gn Gonial	3.00
S N A	0.66
S N B	7.36
S N Pog	4.73
NS, S Gn	2.64
Ao-Bo (Wits)	50.34*
Centroid dental base (CFC-AB)	67.88*
S Gn, AB	87.95*

*P<0.0001

Results

Tables 1, 2 and 3 include descriptive statistics for Class I, II, and III malocclusions. Table 4 shows the analysis of variance for the different classes of malocclusion.

Discussion

The problem of accurately assessing the dental base relationship from anatomically existing points, is central to orthodontic diagnosis. There has been some dispute as to what constitutes the dental base relationship, such as whether only the basal bone or the dento-alveolar structures should be included in the definition. For purposes of consistency in this study, the term will denote the anteroposterior relationship between points 'A' and 'B' whether viewed from nasion or from other aspects of the head.

Applying cephalometric parameters to assess the dental base relationship whether a case is Class I, II or III, skeletal relationship would give a clear indication about the case in hand only if more than one parameter is applied to confirm the other parameters.

In this study the analysis of variance showed several statistically sensitive parameters between the three malocclusion classes. The Sella Gnathion, dental base (SGn; AB), ANB, SN-AB and craniofacial centroid line, AB (CFC, AB) angles were statistically significant P<0.0001.

It seems reasonable to know that the above-mentioned parameters were important in assessing the dental base relationship as shown by workers in the field, including Johnson[1] and Sarhan.[8] However, the Sella-Gnathion dental base angle (SGn; AB) was tested and did confirm its sensitivity when measured against other angles. In fact this angle did not show any overlap between values of different classes as angle ANB or the Wits analysis may show.

Also, it should seem to be of significant value in longitudinal studies by superimposing serial radiographs on the Sella Gnathion Line as used by Downs[18] and Björk.[17] It was suggested by De Coster[16] that the sella turcica is relatively stable after the age of six. Further work by Björk and Skeiller[17] using implants suggests that the mandibular structures of the chin point, the inner cortex of the lower border of the symphysis are stable. Therefore, the general trend for superimposition of lateral x-rays is probably on cranial base and recognized mandibular structures.

Conclusions

1. The angle formed by Sella Gnathion, A and B showed considerable sensitivity in distinguishing between Class I, II and III malocclusions.
2. Values of the angle Sella Gnathion, A,B for Class I are between 30 degrees and 38 degrees; Class II values are between 39 degrees and 54 degrees; Class III values are between 26 degrees and 30 degrees.
3. Sella Gnathion line could be used for superimpositions in longitudinal studies and hence, points A and B could be readily compared.

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