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ASSESSMENT OF FOUR CEPHALOMETRIC MEASUREMENTS UTILIZED IN EVALUATION OF THE MAXILLARY POSITION IN ANTEROPOSTERIOR DIRECTION

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ABSTRACT:

Aim of the work: *The present study was conducted to assess four cephalometric measurements utilized in evaluation of the maxillary position in the anteroposterior direction. The assessment was depending on normality parameters of each measurement and the correlation between them.*

Material and Method: *Lateral cephalometric radiographs of forty Egyptian adults (20 males and 20 females) with an age range from 19-22 years were selected for this purpose. All had accepted normal occlusions, normal skeletal relationship and balanced profiles. The radiographs were traced and the following measurements were done; SNA angle, A point to nasion perpendicular distance, condylion to A point distance, and basion to A point distance. Statistical analyses were performed to asses these four measurements.*

Results: *The results revealed that Ba-A was the best measurement satisfied the normal distribution assumption. Ba-A and SNA angle had the highest symmetrical distribution. There were significant correlation between all measurements except between Co-A and either SNA and A-Np. In addition, there were significant differences between males and females regarding Co-A and Ba-A measurements.*

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Conclusion: *In assessing the maxillary growth, Ba-A measurement satisfied the normal and symmetrical distribution assumption better than the other studied measurements. The males norms of Co-A and Ba-A measurements should not be used for females.*

INTRODUCTION

Cephalometric radiography is considered to be one of the most important tools in orthodontic diagnosis and treatment planning.[1,2] It could be used also for growth prediction and evaluation of treatment outcome.[3-5] In spite of lateral cephalometric radiography is two dimensional radiography, it has long term utilization, wide-ranging data base and reference values and low cost, make it practical for clinical use. On the other hand, the more recent radiographs such as computed tomography and three dimensional radiography present some disadvantages such as; high cost, high dose of radiation, difficulty associated with the definition of anatomical landmarks and insufficient data base storage. These make it impractical for routine application in actual patients.[6]

Many cephalometric analyses were used to assess the maxillary position related to standardized norms were developed. These norms were derived from an untreated sample of subjects from the same ethnic group, who were selected from a population with so called "ideal" or well balanced faces with normal occlusions.[7-23] The diagnostic value of cephalometric analysis depends on the accurate and reproducible identification of clearly defined landmarks. Landmark identification is the main source of cephalometric analysis error.[24,25] Difficulty in identifying cephalometric landmarks are associated with, the images of anatomical structures overlap and that some landmarks are paired with one found on each side of the face consequently, they often appear as double, on coinciding images on lateral radiographs.[25,26] It is also compounded by the variability of the patient's hard and soft tissues. Another important factor that could affect the validity of different cephalometric analysis is the normality parameters of each measurement.[27] The data from which the norms were developed have to satisfy the normal distribution assumption.

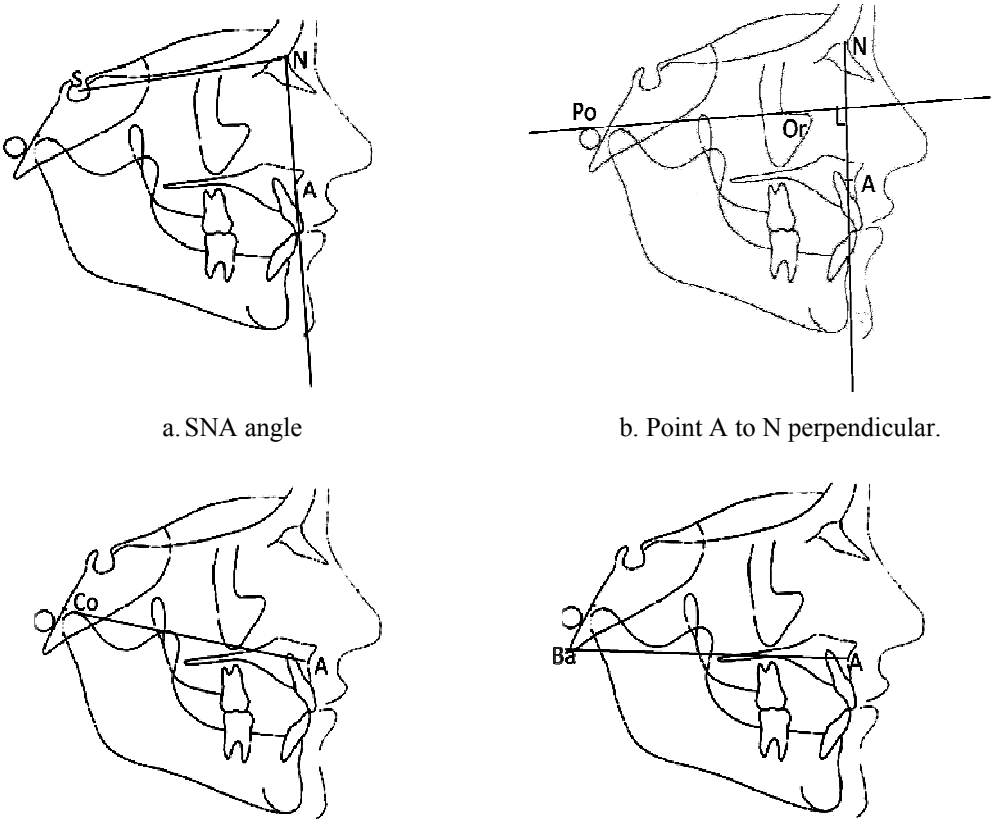
Solow[28] and Järvinen[29] noted that cephalometric measurements evaluating the maxilla have great variability. Both the types of reference points and their location on the osseous contour caused marked variation of these measurements. In addition, almost all of previous studies evaluated cephalometric measurements either through their reproducibility or the stability of landmarks utilized by each measurement to judge its validity. Therefore, the present study was conducted to assess four cephalometric measurements that evaluate the maxillary position in the anteroposterior direction. Assessment was based on comparing the normality parameters of each measurement and the correlation between them. The studied measurements were; Steiner's SNA angle[12], Mc Namara's[30] A point to nasion perpendicular distance and condylion to A point distance, and Clark's [31] basion to A point distance.

MATERIAL AND METHODS

The study was based on forty subjects (20males and 20 females). All were Egyptian with accepted normal occlusions, normal skeletal relationship and balanced profiles. The age ranged from 19-22 years. Lateral cephalometric x-ray film was taken for each subject with the teeth in occlusion. Each film was traced on acetate paper. Landmarks and reference points were located. Then the following four measurements for evaluating the anteroposterior position of the maxilla were made (Figure1):

1. SNA angle: the angle between SN and NA planes.[12]
2. A point to nasion perpendicular distance (A-Np): the horizontal distance between A point and the plane drawn from nasion perpendicular to Frankfort horizontal plane.[30]
3. Condyloin to point A distance (Co-A). [30]
4. Basion to point A distance (Ba-A). [31]

Measurements obtained were corrected for standard magnification. The cephalometric films were retraced and the method error was determined by using Dalhberg's formula which was less than 1 mm and 1 degree.



a. SNA angle

b. Point A to N perpendicular.

c. Condyloin to A point distance.

d. Basion to A point distance.

Figure 1: The four cephalometric measurements for evaluating the anteroposterior position of the maxilla.

STATISTICAL ANALYSIS

The mean and standard deviation were calculated for each group. Normality tests (Kolmogorov-Smirnov and Shapiro-Wilk) and Probability plots (Q-Q plots) were performed to declare if each measurement satisfied the normal distribution assumption. Skewness and Kurtosis tests were also done to evaluate the symmetry of distribution of each measurement. Pearson Correlation Coefficients was utilized to test correlation between the measurements. Student t-test was used to detect differences in measurements between males and females. Significance for all statistical tests was predetermined at $P < 0.05$.

RESULTS

Descriptive statistics of the four measurements for the whole subjects (males and females) including mean and standard deviations are presented in table 1. The results of the tests of normality (Kolmogorov-Smirnov and Shapiro-Wilk) are presented in table 2. Ba-A was the best measurement satisfied the normal distribution assumption. The Q-Q plots and histograms for all measurements were illustrated in figures 2 and 3. The Ba-A was the best measurement matched the normal distribution, where its observations were clustered around the straight line better than the other measurements. In addition, Ba-A observations were distributed in the middle of the histograms better than the other measurements. The results of Skewness and Kurtosis tests revealed that Ba-A and SNA angle had the highest symmetrical distribution (Table 1). The results of correlation coefficient test are illustrated in table 3. There were significant correlation between all measurements except between Co-A and either SNA and A-Np. The means and standard deviations of males and females and results of t test are presented in table 4. There were significant differences between males and females regarding Co-A and Ba-A measurements.

Table 1: Descriptive statistics of the four measurements of the whole sample (males and females).

Measurements		SNA	A-Np	Co-A	Ba-A
Mean		81.4000	1.2750	96.0000	98.4750
95% Confidence Interval for Mean	**Lower Bound**	80.8037	.8528	94.8412	97.1896
	Upper Bound	81.9963	1.6972	97.1588	99.7604
5% Trimmed Mean		81.4167	1.3056	96.0833	98.5833
Median		81.0000	2.0000	96.0000	98.0000
Variance		3.477	1.743	13.128	16.153
Std. Deviation		1.86465	1.32021	3.62329	4.01911
Minimum		77.00	-1.00-	89.00	89.00
Maximum		85.00	3.00	101.00	106.00
Range		8.00	4.00	12.00	17.00
Interquartile Range		3.00	2.00	6.00	5.75
Skewness		-.022	-.187	-.310	-.285
Kurtosis		-.407	-1.380	-1.218	-.113

Table 2: The results of tests of Normality of the whole sample (males and females).

Measurements	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
SNA	.174	40	.004	.952	40	.087
A-Np	.259	40	.000	.855	40	.000
Co-A	.196	40	.000	.918	40	.007
Ba-A	.110	40	.200*	.975	40	.495

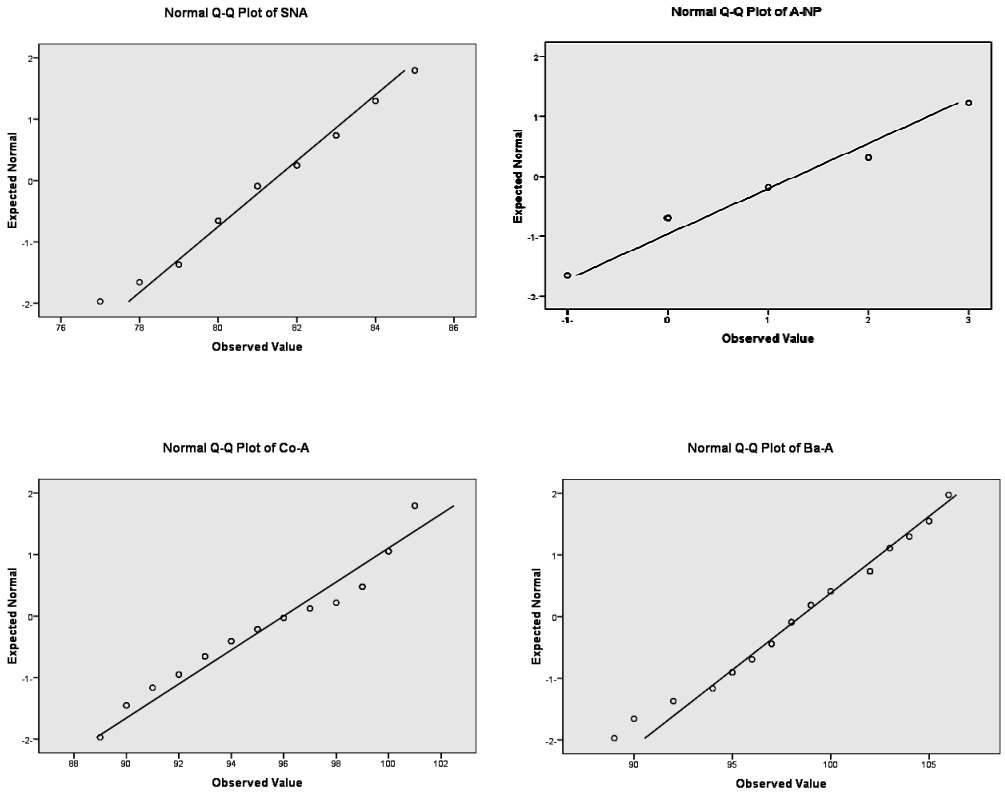


Figure 2: Q-Q probability plots for the four measurements of the whole sample (males and females).

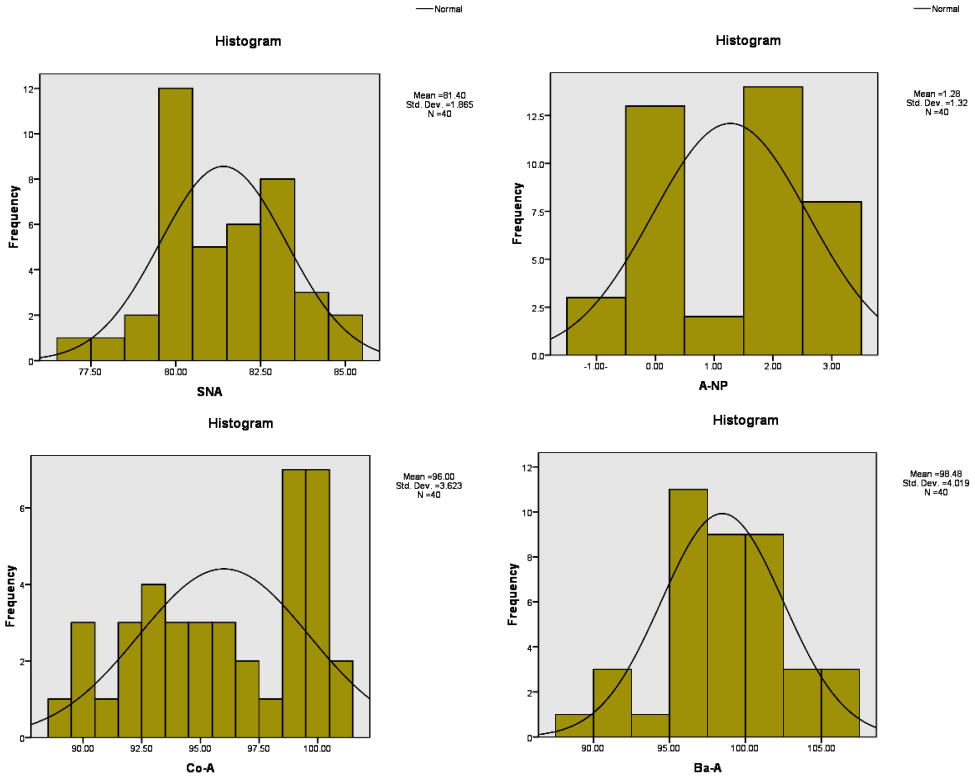


Figure 3: Histograms of the four measurements of the whole sample (males and females).

Table 3: The results of Person Correlation Coefficient test for the four measurements of the whole sample (males and females).

		SNA	A-Np	Co-A	Ba-A
SNA	**Pearson Correlation**	1	.537**	.243	.347*
	Sig. (2-tailed)		.000	.131	.028
	N	40	40	40	40
A-Np	**Pearson Correlation**	.537**	1	.300	.357*
	Sig. (2-tailed)	.000		.060	.024
	N	40	40	40	40
Co-A	**Pearson Correlation**	.243	.300	1	.769**
	Sig. (2-tailed)	.131	.060		.000
	N	40	40	40	40
Ba-A	**Pearson Correlation**	.347*	.357*	.769**	1
	Sig. (2-tailed)	.028	.024	.000	
	N	40	40	40	40

Table 4: The means and standard deviations of males and females measurements and the results of t-test.

Measurements	Males	Females	T	P
SNA	81.65±1.75	81.15±1.98	.845	.403
A-Np	1.50±1.23	1.05±1.39	1.080	.287
Co-A	97.90±2.65	94.10±3.50	3.864	.000
Ba-A	100.55±3.21	96.40±3.70	3.781	.001

DISCUSSION

Assessment of cephalometric measurements usually made through their reproducibility or the stability of landmarks used by each measurement. The present study was conducted to assess four measurements that evaluated the maxillary position in the anteroposterior direction. However, the criteria of assessment were based on comparing the normality parameters of each measurement and the correlation between them. This statistical approach of assessment is of great importance and has to be considered among other guidelines for choosing cephalometric measurements.

In the present study the cephalometric films were retraced and the method error was determined by using Dalhberg's formula which was less than 1 mm and 1 degree. This revealed that the measurements had great reproducibility. In addition, they did not largely unaffected by both systematic and random errors.[24-26] Systematic errors are those related to system as magnification error. On the other hand, random errors are a consequence of uncontrolled variation in the system or technique such as landmark identification error.

The mean values of the present studies (Table 1&4) revealed some variation with those of previous studies. The SNA angle was slightly less than those presented by Steiner[12] (83^o) and McNamara[30] (83.9^o). However, it was closely agreed with those of Downs[8] (81^o), Riedel[32] (82^o), Bishara[33] (81.6^o), and east man standards[34] (81^o). The A- Np length was slightly higher than that of McNamara[30] (1 ± 2.7mm) and much higher than that reported to Chinese population[35] (-0.75 ± 3.6mm). The Co-A was less than McNamara´s[30] males mean (100 ± 6mm) while close to females

mean (93.81±2.28mm). The Ba-A was nearly the same as that of Clark[31] (100.75 ± 4.75mm). These variations between the results of the present study and the other studies could be attributed to differences in ethnic groups, age range and sample size.

The Histograms and Q-Q probability plots (Figure 2&3) illustrated that Ba-A and SNA angle values clustered around straight line better than the other measurements. Accordingly, they had better normality distribution than both the A-Np and Co-A measurements.

Essential parameters in evaluating the distribution are Skewness and Kurtosis of the measurement values. The former is a measure of symmetry while the latter is a measure of the extent to which observations cluster around a central point. In both tests the closer the value to zero, the more close the distribution to normal. The Ba-A showed the best Skewness and Kurtosis results (-.285, -.113) followed by SNA angle (-.022, -.407). On the other hand, both A-Np and Co-A measurements showed the highest Skewness and Kurtosis values (Table 1). Hence, utilizing these measurements may lead to misjudgment.[27] This finding was in harmony with those of previous study regarding the departure from normality of certain measurements.[28]

Regarding the correlation between the studied measurements, the results of the present study revealed significant correlation between most of the studied measurements. Hence, they could be interchangeable in the assessment of the anteroposterior maxillary position. However, there was a non significant correlation between Co-A and either SNA and A-Np. Therefore, these measurements were not interchangeable; however their conjunctive use would be advisable for better evaluation of the maxillary position.

The present study also revealed that there were significant differences between males and females regarding Co-A and Ba-A measurements. This finding could be attributed to the differences in facial morphology between the two sexes. The males usually have more pronounced and muscular faces than females. Therefore it is recommended not to use the male norms for female individuals and vise verse during cephalometric analysis for better assessment and accurate diagnosis.

CONCLUSION

- Ba-A and SNA angle presented more normal symmetrical distribution than Co-A and A-Np.
- Significant correlation was found between the studied measurements except between Co-A and either SNA and A-Np.
- Co-A and Ba-A measurements were significantly different in males and females.

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