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Relationship of ANB Angle and Overjet in different classes of skeletal discrepancy Using Lateral Cephalometry: An in-Vitro Study

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Abstract— Purpose: The objective of this study was to assess the relationship of ANB angle and Overjet using Lateral Cephalometry. Methods and material: The sample included 75 Cephalometric radiographs of patients ranging in age from [15-25] that were selected and collected from the Department of Radiology Faculty of Dentistry (Suez Canal University) .The cephalometric radiographs were divided according to ANB angle into three equal groups with twenty five cephs.in each group,group 1: Twenty Five for Skeletal Class I, group 2: Twenty Five for Skeletal Class II, and group 3: Twenty Five for Skeletal Class III. The relationship between ANB angle and Overjet was measured. **Results:**The correlational analysis of overjet with ANB angle in the three malocclusion classes showed**,** In Class-I showed a weak nonsignificant correlation (r= 0.266; p= 0.198). However, in Class-II, showed a positive significant correlation between overjet and ANB angle (r=0.792; p<0.001). Class-III showed a weak to moderate correlation (r= 0.479; p=0.015). **Conclusions:**ANB angle can be considered as a good predictor for overjet significantly in class II, but in class I and class III, ANB angle is a weak predictor for overjet.

Keywords: Lateral Cephalometry, ANB angle, Anteroposterior jaw relationship, Overjet.

INTRODUCTION

Orthodontic cases must be diagnosed using certain diagnostic instruments, a clinical examination, and the patient's medical history. The goal of a clinical examination is to identify the type and severity of malocclusion and to ascertain if it is a dental or skeletal origin. It also aids in identifying the diagnostic records that might be required. [(1)]. The diagnostic tools include dental casts, radiographs and photographs[(2)] .

For many years, lateral cephalometric radiographs have been utilized to aid in orthodontic diagnosis, planning, and progress. Cephalometric analysis has always been performed manually. The correct identification of distinct landmarks on cephalograms is necessary for these studies to have any diagnostic relevance.Electronic techniques have been developed thanks to the quick advancements in computer technology. Commercially available electronic digitizing equipmenthas made it possible to calculate angles and distances from landmark

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digitalization, and it has the benefit of saving a lot of time compared to manual hand tracing.[3]

Numerous lateral cephalometric analyses have been developed, but the examination of skeletal relationships for jaws in the sagittal plane is of highest importance in orthodontic diagnosis. Wylie introduced the crucial step of analyzing the jaws in the sagittal plane for the first time in 1947. Since then, a variety of methods for evaluating the jaw in the anteroposterior plane have been develop.

As ANB angle was introduced by Riedel in 1950. ANB angle is considered to be the most popular parameter to analyze the skeletal discrepancies in sagittal plane[4-9], though many researchers have found that reliability of ANB angle is affected by changes in SN plane mainly due to superioanterior movement of nasion with growth. Growth rotation and vertical growth also influence the interpretation of ANB [10].Overjet is an important linear parameter that used to assess the sagittal relationship of upper and lower dental arches. The cause of change in overjet could be skeletal, dental, or a combination of both[11].ANB measurement in the Steiner's analysis is used for the assessment of sagittal skeletal relationship. It indicates the magnitude of the skeletal jaw discrepancy and in a normal well proportionate face, ranges from 1 to 5 degrees[12]. However ANB angle has certain limitations. A false value can be recorded with altered anteroposterior and vertical position of nasion, increased or decreased vertical height of the face[13], tipping of SN plane and variation in ANB angle between patient's centric occlusion and centric relation[14].

Therefore, in this study the relationship between ANB angle and Overjet in differentsagittal skeletal discrepancies was studied using Lateral Cephalometry and the reliability of ANB angle in assessment of skeletal sagittal dysplasia in lateral cephalograms was assessed.

MATERIALS AND METHODS

This study was conducted on seventy fiveLateralCephalometric radiographs of patients ranging in age from [15-25] years, after the examination of initial number of 120 radiographcollectedfrom the archives of theOral Radiology department, Faculty of Dentistry, Suez Canal University. The Lateral Cephalometric radiographs included in the present study were of good quality and without any artifacts ofPatients having full set of permanent dentition. .Exclusion criteria were radiographs withcongenital missing, cleft or other congenital craniofacial problems, Patients having previous orthodontic treatment.

Grouping of the sample:

According to the measured ANB cephalometric angle, the sample was divided into three equal groups[15].

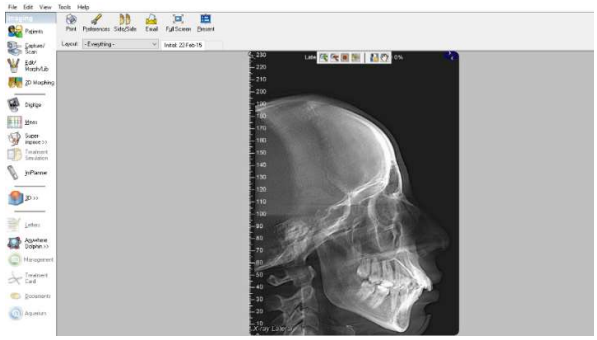
Group 1: Class I – ANB angle between 2–4°, ***Group 2***: Class II – ANB angle is larger than 4° ,***Group 3***: Class III – ANB angle is smaller than 2°

The overjet (mm)classified according to **Brunelle et al. (1996)**[16] into ideal (1 to 2), Mild (3 to 4) in class II or (0) in class III, Moderate (5-6)in class II or (-1 to -2)in class III, sever (7 to 10)in class II or (-3 to -4) in class III, Extreme (>10) in class II or (> -4) in class III.

Radiographic evaluation:

OnDolphin™ imaging[(17)] orthodontic software (Version 11.5, build 36).Each radiographic film was traced to obtainSNA, SNB, ANB angle, Upper and lower incisors' Incisal inclination with the Maxillary plane and the Mandibular plane, respectively, Inter-incisal angle, Overjet and Wits appraisal.

- **Converting the radiographic image into a software image: -**
- By using a digital radiographic system program* installed into hardware ofpersonal computer of capturing; archiving the digital images and then plotting, tracing, and analyzing the traced digital images as in (Figure. 1), (Figure. 2), (Figure 3) and (Figur4)



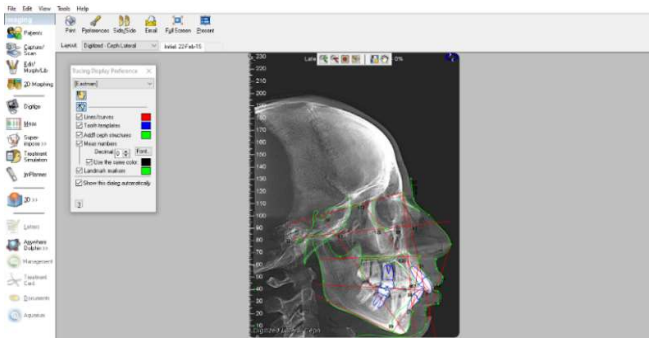
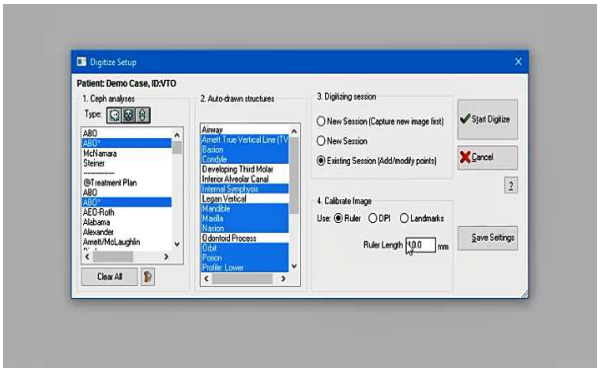


Fig (1): preparing the digital image formarking the selected cephalometric landmarksFig(2) selection of the analysis landmarks



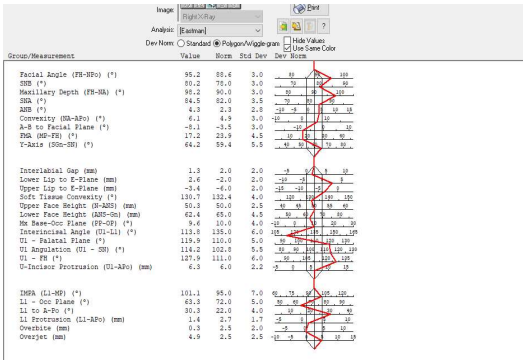


Figure (3): Choosing the type of the analysisFigure (4): the resultant lines and angles

*Dolphin Imaging Software/32 (Version 11.5, build 36)

RESULTS

1. ANB angle

The ANB angle in classes I, II, and III showed an average (±SD) of 2.52±0.94, 6.16±2.56, and -1.11 ±2.03 (Table 1).

Skeletal Class	ANB		
	Mean	**SD**	**SE**
Class-I	**2.52**	0.94	0.19
Class-II	**6.16**	2.56	0.51
Class-III	**-1.11**	2.03	0.41

Table 1. The level of ANB in skeletal classes I, II, and III.

2. Overjet (mm)

2.1. Overjet average

The mean, standard deviation, and standard error of overjet (mm) was presented in Table (2). The average (±SD) overjet of Classes I, II and III recorded a level of 2.28±1.41, 4.91±2.61 and -0.86±2.16 mm

Skeletal Class	Overjet		
	Mean	**SD**	**SE**
Class-I	**2.28**	1.41	0.28
Class-II	**4.91**	2.61	0.52
Class-III	**-0.68**	2.16	0.43

Table 2. Distribution of overjet with respect to malocclusion group.

2.2. Comparison between Classes in Overjet frequency

In Class I, Ideal showed the highest frequency of 18 cases (72.0%), followed by mild with 5 patients (20.0%), followed by moderate 2 (8%), and no recorded patients for sever and extreme (0.0, 0.0%) as presented in table (3). The difference between ideal, mild, moderate, severe and extreme was highly significant as revealed by Chi-square test.

In Class II, the highest frequency recorded a mild overjet (3-4) mm in 10 (40%), followed by ideal (1-2) mm with 6 patients (24%), then by moderate (5-6) mm 4 (16%), and 3 (12%) sever (7-10) mm and 2 (8%) extreme (>10) mm. The difference between ideal, mild, moderate, severe and extreme was non-significant as revealed by Chi-square test.

In Class III, eleven patients (44%) showed moderate (-1 - -2) mm overjet in class III, followed by ten patients (40%) showed ideal (1-2) mm overjet and only two showed sever (-3 - -4) mm overjet. However, mild (0) mm and extreme (>-4) mm was represented by only 1 patient (4.0%), the difference was highly significant as revealed by one way ANOVA.

Table 3. Frequency (n, %) of overjet scores in terms of Ideal, Mild, Moderate, Severe, and extreme.

Class		Overjet score					Total	Chi-square
		Ideal	Mild	Moderate	Severe	Extreme		
Class-I	**n**	18	5	2	0	0	25	**<0.001 *****
	%	**24.0%**	**6.7%**	**2.7%**	**0.0%**	**0.0%**	**33.3%**	
Class-II	**n**	6	10	4	3	2	25	**<0.001 *****
	%	**8.0%**	**13.3%**	**5.3%**	**4.0%**	**2.7%**	**33.3%**	
Class-III	**n**	10	1	11	2	1	25	**<0.001 *****
	%	**13.3%**	**1.3%**	**14.7%**	**2.7%**	**1.3%**	**33.3%**	
Total	**n**	34	16	17	5	3	75	**<0.001*****
	%	**45.3%**	**21.3%**	**22.7%**	**6.7%**	**4.0%**	**100.0%**	
Chi-square		<0.001***						

*, **, ***, significant at p<0.05, <0.01, <0.001; ns, nonsignificant at *p*>0.05.

3. Dental cephalometric measurements

The dental cephalometric measurements including L1/Mp (°), U1-FH (°), U1- NA (°), L1-NB (°), and U1/L1 (°) were described statistically in terms of means ±standard deviation **(Table4).**

Dental cephalometric measurements; L1-MP(°): the angle between the long axis of the lower incisor and mandibular plane; U1-FH(°): angle between the axis of the upper incisor and FH line; U1-NA(°): angle between the axis of the upper incisor and NA line; U1-FH(°): the angle between the long axis of the upper incisor and FH plane; L1-NB(°): angle between the axis of the lower incisor and NB line;U1/L1(°): angle between the axis of the lower incisor and upper The L1-Mp in Class I, II and III showed an average (±SD) of 91.2 ± 7.7, 98.2 ± 5.5, and 85.9 ± 6.6; respectively. The difference between three classes which was highly significant according to one way ANOVA.

U1-FH in Class I, II and III recorded an average (±SD) of 116.0 ± 4.7, 114.2 ± 9.1, and 118.0 ± 7.4; respectively. The difference between classes I, II, and III in U1-FH was nonsignificant as revealed by one way ANOVA.

Furthermore, Dental cephalometric measurements U1-NA in Class I, II and III recorded an average (±SD) of 24.4±3.3, 22.8±5.9, and 27.9±6.6; respectively. The difference between classes I, II, and III in U1-NA was significant (p=0.006) as revealed by one way ANOVA.

Also, Dental cephalometric measurements L1-NB in Classes I, II and III recorded an average (±SD) of 25.9±5.1, 35.4±20.0, and 23.3±4.7; respectively. The difference between classes I, II, and III in L1-NB was significant (p=0.002) as revealed by one way ANOVA.

Besides, Dental cephalometric measurements U1/L1 in Classes I, II and III recorded an average (±SD) of 127.2 ± 7.3, 120.3 ± 11.1, and 129.7 ± 9.0; respectively. The difference between classes I, II, and III in L1-NB was significant (p=0.002) as revealed by one way ANOVA.

For further comparisons between groups, means followed by different letters either vertically (within the same column) or horizontally (within the same row) are significantly different according to DMRTs.

According to two-way analysis of variance, the difference including Classes x cephalometric measures was highly significant.

Table 4. The values of dental cephalometric measurement in classes I, II, and III. Means

	Dental (mean, SD)					**ANOVA (p-value)**
	L1/Mp	**U1/FH**	**U1/NA**	**L1/NB**	U1/L1	
Class-I	91.2 ± 7.7 e	116.0 ± 4.7 bc	24.4 ± 3.3 h	25.9 ± 5.1 h	127.2 ± 7.3 a	<0.001***
Class-II	98.2 ± 5.5 d	114.2 ± 9.1 c	22.8 ± 5.9 h	35.4 ± 20.0 g	120.3 ± 11.1 b	<0.001***
Class-III	85.9 ± 6.6 f	118.0 ± 7.4 bc	27.9 ± 6.6 h	23.3 ± 4.7 h	129.7 ± 9.0 a	<0.001***
ANOVA	<0.001***	0.197 ns	0.006**	0.002**	0.002**	
Two-way Analysis of variance						
Cor-Model	<0.001***					
Skeletal class	0.422 ns					
measure	<0.001***					
Class x measure	<0.001***					

followed by different letters are significantly different according to DMRTs

*, **, ***, significant at p<0.05, <0.01, <0.001; ns, nonsignificant at *p*>0.05.

4. Interaction between Overjet and ANB

The correlation between overjet and ANB angle presented in (table 5). In Class-I showed a weak non significant correlation (r= 0.266; p= 0.198). However, in Class-II,

showed a positive significant correlation between overjet and ANB angle (r=0.792; p<0.001). Class-III showed a weak to moderate correlation (r= 0.479; p=0.015).

Class	Correlation between ANB and Overjet	
	r	p-value
Class I	0.266	0.198 ns
Class II	0.792	<0.001***
Class III	0.479	0.015*
Overall	0.844	<0.001***

Table 5. Correlation between Overjet and ANB angle.

Discussion

Among the criteria required for diagnosis and treatment planning, the sagittal relationship between maxilla and mandible is critical. ANB angle is the mostly used cephalometric parameter to assess the sagittal skeletal relationship between upper and lower arches. Correction of sagittal dysplasia is very important in achieving balanced profile after orthodontic treatment.

Overjet is one of the most dental parameter used to assessthe sagittal relationship of upper and lower dental arches and the orthodontist cares a lot about Its diagnosis before treatment and it's correction after orthodontic treatment.[2]

Therefore, within each class of malocclusion according to ANB angle, the average values of ANB angle and overjet were calculated and their correlations tested. The extent to which ANB angle can determine overjetwas assessed.A positive correlation was expected between overjet and ANB, because they both directly reflect the jaw relationships in the sagittal plane. But alteration can occur, which is probably due to the fact that overjet is influenced by inclinations of the upper and the lower incisors and ANB also depends on the anteroposterior position of nasion, inclination of the SN line, maxillary inclination, and the vertical position ofnasion.

Any different horizontal or vertical position of point N and the location of points A and B in the vertical plane will influence the ANB angle and not the actual sagittal relationship of the jaws. The inclination of the occlusal plane also affects ANB, although the sagittal relationship remains constant.[18]

Analyzing the results:

Regarding the reliability of ANB angle in assessment the sagittal skeletal relationship:

ANB angle was used in this study in assessment of sagittal skeletal relationship, in agreement with***Ishikawa et al[4],Ahmed et al[19], Azeez and Khalid[5], Ahmad and Jahjah[6],Qamaruddin et al[10], Alhammadi et al[7], Gupta et al[20], Asudaria et al[8], Bhullar et al[9].***

Regarding the relationship between ANB angle and overjet in the three skeletal classes:
The correlational analysis between overjet and ANB angle in three malocclusion classes showed that:
In Class-I, The correlational analysis between overjet (2.2 mm) and ANB angle (2.5^{o}) was a weak nonsignificant correlation (r= 0.266; p= 0.198).
This could be explained on the basis that there was mild dental compensation by the inclination of the upper and lower incisors as revealed by the measures of (U1/FH)^{o} which recorded an average (±SD) of 116.0 ± 4.7, (U1/NA)^{o} recorded an average (±SD) of 24.4±3.3, (L1/MP)^{o} showed an average (±SD) of 91.2 ± 7.7, (L1/NB)^{o} recorded an average (±SD) of 25.9±5.1, (U1/L1)^{o} recorded an average (±SD) of 127.2 ± 7.3, this was in agreement with **Zupancic*et al*[11]*Abdul Jabbar and Mahmood[18],Ahmed et al[19], Taloumtzi et al[21].***

However, in Class-II, The correlational analysis between overjet (4.9 mm) and ANB angle (6.16^{o}) showed a positive significant correlation (r=0.792; p<0.001)**.**

This could be explained on the basis that there was no dental compensation by the the upper and lower incisors as revealed by the measures of (U1/FH)^{o} which recorded an average (±SD) of 114.2 ± 9.1, (U1/NA)^{o} recorded an average (±SD) of 22.8±5.9, (L1/MP)^{o} showed an average (±SD) of 98.2 ± 5.5, (L1/NB)^{o} recorded an average (±SD) of 35.4±20.0, (U1/L1)^{o} recorded an average (±SD) of 120.3 ± 11.1, this was in agreement with**Zupancic*et al*[11], *Shrikant et al[22],Ghani and Jabbar[23],Ahmed et al[19], Taloumtzi et al[21].***
In Class-III, The correlational analysis between overjet (-.68 mm) and ANB angle (-1.11^{o}) showed a weak to moderate correlation (r= 0.479; p=0.015)**.**

This could be explained on the basis that there was mild dental compensation by the inclination of the upper and lower incisors as revealed by the measures of (U1/FH)^{o} which recorded an average (±SD) of 118.0 ± 7.4, (U1/NA)^{o} recorded an average (±SD) of 27.9±6.6, (L1/MP)^{o} showed an average (±SD) of 85.9 ± 6.6, (L1/NB)^{o} recorded an average (±SD) of 23.3±4.7, (U1/L1)^{o} recorded an average (±SD) of 129.7 ± 9.0**,** This was in agreement with **Zupancic*et al*[11]*Shrikant et al[22], Abdul Jabbar and Mahmood[18],Ghani and Jabbar[23],Ahmed et al[19].**

The results in the present study was not in agreement with ***Zhou et al (2008)[24].***
This is because they found that linear measurements (WITS APPRAISAL) of antero-posterior jaw-base relationships are more accurate than angular measurements (ANB angle) in reflecting the dental arch relationship.

The results in the present study was not in agreement with ***Abdul Jabbar and Mahmood (2012)[18],*** Thisis because they found that overjet isinfluenced by inclinations of the upper and

the lower incisors and ANB also depends on the anteroposterior position of nasion, inclination of the SN line, maxillary inclination, and the vertical position of nasion and any different horizontal or vertical position of point N and the location of points A and B in the vertical plane will influence the size of ANB and not the actual sagittal relationship of the jaws. The inclination of the occlusal plane also affects ANB, although the sagittal relationship remains constant

The results in the present study was not in agreement with***Aldrees (2012)***[25], This is due to difference in sample size and ethnic backgroundand not in agreement with ***Kumar and Sundareswaran (2014)***[26]Because they found that that Overjet was not a good predictor of sagittal dysplasia in Class I and III malocclusion, but it was a statistically significant predictor in Class II division I malocclusion because of the geometric effect of changes in N point position horizontally and vertically on ANB angle**.**

Conclusion

1. In class I, there is a weak non-significant correlation between ANB angle and overjet
2. In class II, there is a positive significant correlation between overjet and ANB angle
3. In class III, there is a weak to moderate significant correlation between ANB angle and overjet
4. ANB angle can be considered as a good predictor for overjet significantly in class II as there was no dental compensation but in class I and class III, ANB angle is a weak predictor for overjet due to mild dental compensation that occurs in upper and lower incisors.

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