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Assessing the Relation among Various Methods of Measuring the Anteroposterior Jaws Relation

Shahba'a A. Mohammed, B.D.S., M.Sc.[1], Layth M. K. Nissan, B.D.S., M.Sc.[2], Sara M. Jassim Al-Mashhadany, B.D.S., M.Sc.[3] ,Mohammed Nahidh, B.D.S., M.Sc.[4]

[1] *Assistant Professor. Department of Orthodontics. College of Dentistry, University of Baghdad.*
[2] *Lecturer. Department of Orthodontics. College of Dentistry, University of Baghdad.*
[3] *Lecturer. Department of Orthodontics. College of Dentistry, University of Baghdad.*
[4] *Assistant Professor. Department of Orthodontics. College of Dentistry, University of Baghdad.*

Abstract
Background: *Assessment of sagittal jaws relation is a vital procedure in establishing a good diagnosis for all orthodontic cases. This study aimed to find out the relation among different methods determining the sagittal jaws relationship.*
Materials and methods: *Sixty digital true lateral cephalometric radiographs belong to dental students and patients attending the orthodontic clinic in the College of Dentistry, University of Baghdad were selected as a sample for this study. The radiographs were classified according to the ANB angle into 3 groups with 20 radiograph per. Six measurements were employed to assess the sagittal relation and to get the relation among them using Pearson's correlation coefficient test.*
Results: *The results revealed higher mean values of all parameters measured in Class II followed by Class I then Class III. ANB angle showed direct significant relation with all variables in class I only. It showed direct significant relation with Wits' appraisal in class II and III.*
Conclusions: *The relation among different measurements that determine the sagittal jaws relation may not always be significant because of different inclinations of the planes and points positions used in assessment.*
Keywords: *Orthodontic diagnosis, sagittal jaws relation, ANB, Wits' appraisal.*

I. Introduction

One of the most important points in successful orthodontic treatment is the accurate diagnosis. Orthodontic diagnosis comprised a series of steps starting from the patient's history, clinical examination (extra- and intra-oral) in addition to information from the diagnostic aids (study cast, OPG and lateral cephalometric radiographs). Upon examination, skeletal, soft tissue and dentition should be considered in three planes of space.

Sagittal or anteroposterior skeletal jaws relation is far essential to be interpreted clinically by visual profile analysis or two finger method of Foster [(1)]. These methods carried many drawbacks that may give false diagnosis, so a conformation with a lateral cephalometric radiograph after its discovery in 1931 by Broadbent and Hofrath [(2,3)] is so vital.

Many authors [(4-28)] developed a lot of cephalometric analyses that deduced the sagittal jaws relation since 1947 both angular and linear. Those authors depended mainly of the relation of the maxilla and mandible to the cranial base or other planes like Frankfort, palatal and occlusal plane.

In a very great and concise articles written by Kumar and Sundareswaran [(29)] in 2014 and Singh *et al.* [(30)] in 2015, more than 20 cephalometric methods assessing the sagittal jaws relation had been discussed. The purpose of this study is to find out the relation among different cephalometric methods utilizing different cephalometric planes.

II. Materials And Methods

Materials

Sixty digital true lateral cephalometric radiographs were chosen from the records of the dental students and patients attending the orthodontic clinic in the College of Dentistry, University of Baghdad. All of the subjects were Iraqi Arabs with an age ranged between 18 and 30 years old. All had full complement of dentition regardless the wisdom teeth. All of them never get orthodontic and / or orthognathic treatment or had craniofacial disorder.

Depending on the ANB angle of Riedel [(7,8)], the samples were classified as Class I, II and III. Sample with ANB angle between 2º-4º was considered as Class I, above 4º as Class II and below 2º as Class III. For each class, 20 radiographs were selected; 10 per each gender.

Methods

The radiographs were imported and analyzed using AutoCAD software (2007). Firstly, the magnification was corrected using the ruler build-in in the nasal rod, then the cephalometric points, planes were determined and the measurements were obtained.

Cephalometric points, planes and landmarks [7,11,12,19,20,24,31,32]

Cephalometric points

1. Point S (Sella): The midpoint of the hypophysial fossa.
2. Point N (Nasion): The most anterior point on the nasofrontal suture in the median plane.
3. Point A (Subspinale): The deepest midline point on the premaxilla between the Anterior Nasal Spine and Prosthion.
4. Point B (Supramentale): The deepest midline point on the mandible between Infradentale and Pogonion.
5. Point ANS (Anterior Nasal Spine): It is the tip of the bony anterior nasal spine in the median plane.
6. Point PNS (Posterior Nasal Spine): This is a constructed radiological point, the intersection of a continuation of the anterior wall of the pterygopalatine fossa and the floor of the nose. It marks the dorsal limit of the maxilla.
7. Point Po (Porion): The most superiorly positioned point of the external auditory meatus.
8. Point Or (Orbitale): The lowest point on the inferior rim of the orbit.
9. Point Is (Incisor superius): The tip of the crown of the most anterior maxillary central incisor.
10. Point Ii (Incisor inferius): The tip of the crown of the most anterior mandibular central incisor

Cephalometric planes

1. Sella-Nasion (SN) plane: It is the anteroposterior extent of anterior cranial base.
2. N- A line: Formed by a line joining Nasion and point A.
3. N- B line: Formed by a line joining Nasion and point B.
4. Functional occlusal plane: A line drawn through the region of the overlapping cusps of the first premolars and first molars.
5. Palatal plane (PP): A line joining between anterior nasal spine and posterior nasal spine.
6. Frankfort plane: Formed by points machine Porion and Orbitale.
7. A perpendicular line from point A onto the SN plane.
8. A perpendicular line from point B onto the SN plane.
9. A perpendicular line from point A onto the palatal plane.
10. A perpendicular line from point B onto the palatal plane.
11. A perpendicular line from point A onto the functional occlusal plane.
12. A perpendicular line from point B onto the functional occlusal plane.
13. A perpendicular line from point A onto the Frankfort plane.
14. A perpendicular line from point B onto the Frankfort plane.

Cephalometric measurements

1. ANB angle: The angle between N-A and N-B lines.
2. Overjet: The linear distance between the Incisor superius and Incisor inferius parallel to the occlusal plane.
3. Wits appraisal: The linear distance between the intersections of points A and B on the functional occlusal plane.
4. APP-BPP: The linear distance between the intersections of points A and B on the palatal plane.
5. AF-BF: The linear distance between the intersections of points A and B on the Frankfort plane.
6. AB/SN: The linear distance between the intersections of points A and B on the SN plane.

Statistical Analyses

All the data of the sample were analyzed using SPSS version 21 software. The statistical analyses included:

1. Descriptive Statistics including; means, standard deviations (SD) and statistical tables.
2. Inferential Statistics; Pearson's coefficient of correlation (r) to show the relation among variables.

In the statistical evaluation, the following levels of significance are used:

Non-significant	$P > 0.05$
Significant	$0.05 \geq P > 0.01$
Highly significant	$P \leq 0.01$

III. Results

Table 1 demonstrated the descriptive statistics of the parameters measured. Generally, the mean values were higher in class II followed by class I and III.

The tables 2-4 demonstrated the relationship among the variables measured in class I, II and III. In class I sample, ANB angle correlated significantly with all parameters except overjet in class I sample. APP-BPP distance also correlated significantly with Wits' and AF-BF distance and the latter correlated with AB/SN distance.

In class II sample, only ANB correlated significantly with Wits' and AF-BF distance with AB/SN distance. While in class III, Wits' correlated with the ANB angle, on the other hand, AB/SN distance correlated with AF-BF and APP-BPP only.

Table 1: Descriptive statistics of the parameters measured

Parameters	Genders	Class I		Class II		Class III	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
ANB (º)	Total	2.85	0.81	6.5	1.32	-0.55	1.36
	Males	2.9	0.74	6.7	1.49	-0.5	1.72
	Females	2.8	0.92	6.3	1.16	-0.6	0.97
Overjet (mm.)	Total	2.21	0.62	5.69	1.88	1.71	0.69
	Males	2.5	0.49	5.56	1.41	1.89	0.75
	Females	1.93	0.63	5.82	2.34	1.53	0.61
Wits' Appraisal (mm.)	Total	0.44	1.65	4.73	1.56	-2.33	1.82
	Males	1.6	0.97	5.63	1.48	-1.64	2.08
	Females	0.73	1.34	3.84	1.08	-3.02	1.26
APP-BPP (mm.)	Total	5.02	2.5	9.28	1.35	1.66	1.35
	Males	5.58	2.62	9.29	1.44	2.57	1.1
	Females	4.47	2.38	9.28	1.33	0.76	0.9
AF-BF (mm.)	Total	4.87	1.26	9.33	2.28	0.86	2.15
	Males	4.64	1.16	9.83	1.73	2.29	1.54
	Females	5.1	1.38	8.83	2.72	-0.56	1.69
AB/SN (mm.)	Total	9.44	1.81	14.72	2.48	6.63	2.01
	Males	8.97	1.78	14.52	2.32	7.97	1.57
	Females	9.91	1.81	14.92	2.74	5.3	1.47

Table 2: Relation among variables in Class I sample

Variables		Overjet	Wits'	APP-BPP	AF-BF	AB/SN
ANB	r	0.296	0.464	0.474	0.567	0.520
	p	0.206	0.039	0.035	0.009	0.019
Overjet	r		0.324	0.352	-0.024	-0.021
	p		0.164	0.128	0.920	0.929
Wits'	r			0.484	0.262	0.167
	p			0.031	0.264	0.482
APP-BPP	r				0.479	0.503
	p				0.033	0.024
AF-BF	r					0.699
	p					0.001

Table 3: Relation among variables in Class II sample

Variables		Overjet	Wits'	APP-BPP	AF-BF	AB/SN
ANB	r	-0.092	0.480	0.287	0.355	0.262
	p	0.700	0.032	0.219	0.124	0.265
Overjet	r		0.239	0.067	0.078	0.206
	p		0.309	0.778	0.745	0.384
Wits'	r			0.183	0.427	0.334
	p			0.439	0.061	0.150
APP-BPP	r				0.379	0.403
	p				0.099	0.078
AF-BF	r					0.587
	p					0.007

Table 4: Relation among variables in Class III sample

Variables		Overjet	Wits'	APP-BPP	AF-BF	AB/SN
ANB	r	0.142	0.568	-0.234	0.324	0.027
	p	0.550	0.009	0.320	0.164	0.909
Overjet	r		0.257	0.239	-0.128	-0.011
	p		0.053	0.310	0.591	0.965
Wits'	r			0.237	0.348	0.349
	p			0.315	0.133	0.131
APP-BPP	r				0.418	0.507
	p				0.067	0.023
AF-BF	r					0.455
	p					0.044

IV. Discussion

Most of the measurements assessing the sagittal jaws relation depended on points and planes found in the cranium. Points A and B of Downs (6) were the most popular points and the most widely used as they represented the apical base limit in both jaws. One of the disadvantages of these points were the difficulty in their determination in addition to the effect of growth and orthodontic treatment in changing their positions, so efforts of the authors directed towards using another stable points (22).

Cephalometric planes, on the other hand, may affect the assessment of the sagittal jaw relation as they may had variable inclinations depending on the anatomical variation of the points, the soft tissue factors, difference in the vertical jaws relation and the effect of dento-alveolar compensation in modulating the dental arches and teeth to get normal dental relationship although there is skeletal discrepancies.

To minimize the growth factor (33), the sample of this study was chosen above the age 18 years old. All of the subjects had complete permanent dentition with no submerged, congenital missing or supernumerary teeth that may affect the inclination of the occlusal plane.

The ANB angle was developed by Riedel (7) in 1948. Till now it is considered the most popular and widely used method. In the present study, the mean values of this angle are near to that of Riedel's standards. This angle shows direct significant correlation with all other variables measured in class I sample where there is no or little skeletal discrepancy.

Wits' appraisal of Jacobson (12) passes up point N and diminishes the rotational effects of jaws growth. It depended on points A and B that dropped onto the functional occlusal plane. This plane is dental not skeletal and can be affected with the teeth eruption and orthodontic treatment (34-36). The mean values of this measurement are near to that of Jacobson. It showed direct significant correlation with ANB angle in all classes. Also it showed direct significant correlation with APP-BPP in class I only. This may be attributed to the normal inclinations of the palatal and occlusal plane in class I sample. In the other classes, it is hard to find that because in class II and III, there are different variations in the vertical relation in addition to the effect of soft tissues in worsening the case and vice versa.

In 1987, Chang (19) developed the AF-BF distance after dropping perpendiculars from point A and B onto the Frankfort plane. This plane depended on the points Porion and Orbitale. Any anatomical variation in any point may have an erroneous effect on the reading specially point Porion, so some authors preferred the machine Porion (32). The mean values of this distance are slightly higher than Chang's standard; this may be due to different inclinations of Frankfort plane. Again direct significant correlation was found between this distance and ANB angle and APP-BPP distance in class I only.

Nanda and Merrill (20) in 1994 adopted APP-BPP distance as a measure of sagittal jaws relation. In this study, the mean values of this distance are same of the author's standards. In their study, Nanda and Merrill (20) excluded the effect of point N and declared that the palatal plane is more stable. Actually, this plane is affected by the vertical heights variations as it is rotated downward anteriorly in Class II division 2 malocclusion or backward posteriorly in open bite cases. In this study, it showed direct significant correlation with ANB angle and AF-BF and AB/SN distance in class I and with the latter in class III also.

AB/SN distance was also used in this study and previously was used by Tylor (11) in 1969 and Al-Bashir and Al-Mulla (37) in 1997. This measurement depended on S-N plane which is subjected to various inclinations due to the anteroposterior or the vertical position of point nasion. AB/SN distance showed direct significant correlation with ANB angle and AF-BF distance.

Overjet represents the sagittal relation between the most proclined maxillary and mandibular incisors. In this study, overjet shows non-significant relation with all of the measurements because it represents teeth relation not skeletal relation also the inclinations of both incisors may be affect to some extent by the dento-alveolar compensation. Zupancic *et al.* (24) reported that overjet is considered a good indicator of sagittal relation in class II division 1 malocclusion.

V. Conclusions

The relation among different measurements that determine the sagittal jaws relation may not always significant because of different inclinations of the planes used and different position of point N in some methods.

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