Original Article

Evaluation of Correlation between Wits' Appraisal and a New Method for Assessment of Sagittal Relationship of Jaws

Z. Hedayati[1✉], S. Heidari[2], F. Khaje[3]

[1]Orthodontic Research Center, Associate Professor and Head of Orthodontic Department, School of Dentistry, Shiraz University of Medical Sciences. Shiraz, Iran
[2]Assistant Professor, Department of Orthodontic, School of Dentistry, Bushehr University of Medical Sciences. Bushehr, Iran
[3]Orthodontic Research Center, Assistant Professor, Department of Orthodontic, International Branch, Shiraz University of Medical Sciences. Shiraz, Iran

✉ Corresponding author:
Z. Hedayati, Orthodontic Research Center, Associate Professor and Head of Orthodontic Department, School of Dentistry, Shiraz University of Medical Sciences. Shiraz, Iran
hedayatz@yahoo.com

Abstract

Background and Aim: Although Wits' appraisal is a valuable measurement for sagittal jaw relationship evaluation in orthodontic patients, occlusal plane detection is difficult in a lot of cases or is challenging due to its various inclinations. In this study, a new method for assessment of sagittal skeletal relationship is introduced and the purpose of this investigation is to evaluate correlation between wit's appraisal and this new method.

Materials and Methods: Lateral cephalograms of 71 orthodontic patients (male and female) from all types of skeletal malocclusions (class I, II, III) were collected and analyzed. Two perpendicular lines were traced to Frankfort Horizontal plane (FH) and also to functional occlusal plane (Wit's) from points A and B. Distances of points of contacts on both occlusal and functional occlusal planes were measured. Pearson Correlation analysis was performed to assess the relationship between AO´-BO´ distance on FH (called q) and Wits' appraisal. Correlation of these variables was evaluated with SNA, SNB, ANB and overjet, separately.

Results: The results showed a high correlation of variables using Frankfort Horizontal plane and Wits' appraisal (r= 0.82). Both methods revealed significant statistical relationship with SNA, SNB, ANB and overjet (p< 0.05). The highest scores of correlation with ANB were obtained in using both methods.

Conclusion: The use of measurement is as much valuable as the usual Wits' measurement and it can be a good alternative in patients when tracing the accurate occlusal plane is impossible or difficult.

Key Words: Wits' appraisal, functional occlusal plane, frankfurt plane

Introduction

Many years after introduction of lateral cephalometry to dentistry and particularly to orthodontics and disclosure of its numerous benefits in demonstration of the relationships between skeletal and dental structures as well as their relationships to the facial soft tissues, it has become an integral part in orthodontic diagnosis and treatment planning. One of the most important and common applications of lateral cephalograms is determining anteroposterior position of jaws relative to each other, which is extremely important in determining type of orthodontic treatment, and especially in deciding whether orthodontic treatment alone or in combination with surgery is required. ANB angle (difference between SNA, SNB) is the most com-

mon diagnostic method in evaluating anteroposterior jaw relationship by using cephalometric points. Many dentists still use this angle as the absolute indicator of the anteroposterior jaw discrepancies [1-4]. The N, A, and B points are easily found, hence, this angle is readily and easily measured. But, the problems with ANB angle were quickly exposed, and in 1995, Jenkins was the first to investigate the short-comings of ANB angle [5]. The main disadvantage of ANB angle is being influenced by jaw rotation, and thus, can easily be influenced by the patient's skeletal growth pattern [1, 3-4]. Attempts to re-solve this problem led researchers to think of other landmark approaches for evaluation of anteroposterior jaw growth, and gradually atten-tions were drawn to use of functional occlusal plane. Jenkins [5] and Harold [6] were pioneers in using the functional occlusal plane in evaluation of anteroposterior jaw relationship. Ultimately, in 1985, Jarvinen emphasized that ANB angle varies with factors other than changes in the anteroposterior position of the jaws, and proposed Wits' appraisal (also considered a few years earli-er) as an alternative to ANB angle approach [7].

Wits' appraisal is a linear measurement carried out on the functional occlusal plane. Two perpendicu-lar lines are drawn from points A (on the upper jaw) and B (on the lower) to the occlusal plane. Where these lines meet occlusal plane are called AO and BO. The distance between these points, measured in millimeter, determines numerical Wits' appraisal value (figure1).Contrary to ANB angle, this method has the advantage that, is not af-fected by patients' growth, and is highly reliable in treatment planning for adults and adolescents [8-10].

The problem arises when drawing patient's occlusal plane becomes difficult or even impossi-ble, such as in cases where large numbers of per-manent teeth have not yet erupted, or when prima-ry teeth, due to decay, normal exfoliation or early extraction are not present in the mouth. Also, due to missing or impaction of several teeth, or severe abnormalities in the shape and size of teeth, the dentist is unable to draw occlusal plane in cephalograms. Faced with such dilemma, inevita-bly, other reference lines must be found for evalu-ating anteroposterior jaws relationship (without the influence of patients' growth pattern or rotation of the jaws). A reference line used in numerous cephalometric measurements is the Frankfort Hori-zontal plane (FH) obtained by connecting porion (Por) to orbitale (Or) points, and is commonly used in cephalometric tracing for most patients. In this study, perpendicular lines drawn from A and B points on this plane were used, so that, with elimi-nation of occlusal plane, it could be compared with Wits' in effectiveness and determination of similar values (figure2). In routine conditions- in patients with normal occlusion, drawing Frankfort plane is much harder than occlusal plane. However, in situ-ations where status of patients' teeth is not condu-cive to drawing occlusal plane, Frankfort plane could be most helpful. It seems necessary to find a way for evaluating anteroposterior jaws relation-ship that is not influenced by patient's growth pat-tern, and is capable of being applied to patients with any dental conditions.

This study attempts to find a method with similar accuracy to Wits' (when Wits' measurement can-not be applicable) capable of evaluating anteroposterior jaws relationship without the influ-ence of occlusal plane rotation, or facing the den-tist with difficulties in drawing occlusal plane due to incomplete eruption of teeth. To achieve this purpose, the correlation between Wits' measure-ment and those of the proposed method was as-sessed.

Figure 1: A and B points on the functional
occlusal plane

Materials and Methods

This retrospective cross-sectional study was carried out, using lateral cephalogram radiographs from 71 orthodontic patients' files (male and female). Patients' age ranged from 15 to 25 years, with permanent dentition. Patients were selected from amongst three skeletal malocclusion groups of class I (21 patients), class II (20 patients), and class III (30 patients) according to ANB angle. Patients with ANB angle of 2°±2 were placed in class I group, those with ANB angle higher than 4° were in class II, and with ANB angle less than zero were in class III. Patients with severely horizontal or vertical jaw growth patterns and clear rotations of the jaws were excluded from the study. Tracing the radiographs were carried out by one of the practitioners and the A, B, N, S, Por, and Or landmarks were marked. Then, the functional occlusal plane was drawn in the gap between the occlusal contact of the upper and lower primary premolar teeth with upper and lower primary molar teeth.

The new measurement called "q" is designed for evaluation of anteroposterior jaw relationship on the Frankfort plane. This is a linear measurement, showing linear distance between the images of A and B points on this plane (figure 2).
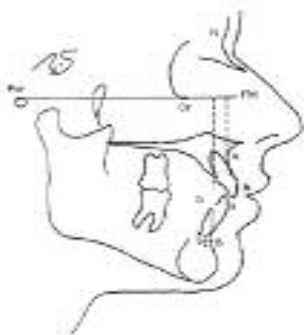

Figure 2: Images of the A and B points on the Frankfort plane

The following angular and linear measurements were taken; SNA, SNB, ANB, overjet (OJ), Wits', and q (linear measurement of perpendicular line distance from A and B points on the Frankfort plane) (table 1). The SPSS-11.5 software and Pearson Correlation test were used for analysis of results. Correlation coefficient between Wits' and OJ, angles SNA, SNB, ANB, and q measurement were calculated. Similar calculations were conducted to determine correlation between q and the above values. Correlation with $P<0.05$ was considered significant. To assess the reliability of measurements, 10 cephalometrics films from each malocclusion group were randomly selected two weeks after initial measurements and linear and angular measurements were repeated. Data were analyzed by paired t-test.

Table 1: The mean and standard deviation of measurement of variables

Variables	Mean	Standard deviation
SNA	82/5	3/8
SNB	81/3	3/9
ANB	1/5	4/5
WIT'S	-2/7	5/9
OJ	0/18	4/7
q	-2/3	6/7

Results

The paired t-test analysis showed the results of two measurements (intra-observer reliability)were acceptable ($P<0.05$). As can be seen in table 2, there was a significant correlation (r) between Wits' and SNA, ANB, SNB, OJ, and q ($P<0.05$). The same was observed with the correlation between q and SNA, SNB, ANB, and OJ. The correlation between q and Wits' showed values of r=0.82 with $P<0.001$.The most and the least correlation of Wits' was observed to be with ANB (r=0.85) and SNA (r=0.49) respectively. The most and the least correlation of q was shown to be in relation with ANB (r=0.92) and SNA (r=0.24) respectively.

Discussion

Several methods have been used for evaluation of anteroposterior relationship of upper and lower jaws. This evaluation is highly important because, by defining reliable indicators, the distinction can

be made more confidently between patients requiring orthodontic treatment only and those that need jaw surgery as well. For this purpose, different

Table 2: Correlation coefficients between measurements

Variables	Wits' measurement	q
SNA	R=0.493**	R=0.297*
	P=0.000	P=0.012
SNB	R=0.508*0.508**	R=0.764-0.764**
	P=0.000	P=0.000
ANB	R=0.851**	R=0.925
	P=0.000	P=0.000
OJ	R=0.806**	R=0.761**
	P=0.000	P=0.000
q	R=0.828**	
	P=0.000	

**p<0/01

* P<0/05

skeletal (ANB) and dental (overjet) indicators have been used by different researchers. However, as dental indicators are affected by the surrounding factors, they are less used. Zupancic et al. believe that dental relations are not always able to reflect the anteroposterior state of the related skeletal structures, and only in class II malocclusion patients, overjet can be used confidently to predict sagittal jaw relationships [11]. Whilst, more than other methods, indicators based on skeletal parameters (with ANB angle most frequently used) are used for this purpose.

Since several studies have shown that ANB angle is highly affected by geometric factors, use of alternative linear and angular measurements that can show correct anteroposterior jaw relationship without being much influenced by various factors seems necessary. Even until very recently, extensive efforts were made to find a solution to this problem. For instance, Baik and Ververidou used cephalometric indicators including A and B points and drew an axis from the mandibular condyle (Co) to form an angle called "beta angle", and used it to determine anteroposterior jaw relationship [16].

With the numerous methods suggested, Wits' measurement is still the most widely used alternative to ANB angle. Wits' measurement is capable of showing sagittal relationship between the maxillary and mandibular skeletal base and teeth [17], using either anatomic or functional occlusal planes. But, the question is that what can be done when extensive loss of anterior and posterior teeth in both jaws prevents drawing of occlusal plane. Results of this study showed that using perpendicular lines to the Frankfort plane (almost always drawn in the cephalometry tracing process) drawn from A and B points and measuring the distance between them (q) approximates Wits' value in patients. Because of its high correlation with Wits' and also with ANB, q is sufficiently valuable to replace Wits' (when drawing occlusal plane is difficult or impossible).

There is a significantly positive correlation between Wits' and q with SNA (that indicates sagittal position of maxilla). This means increase in Wits' and q values will occur when maxilla is protruded and SNA angle is more than normal. Although, this correlation is statistically significant, it indicates the lowest numerical value of "r", compared to other measurements.

The correlation between Wits' and q with SNB angle is also significant, but, higher values of q and Wits' correlate with lower values of SNB angle. This means, with lower SNB angle when mandible is in a more retruded position compared to the base of the skull, Wits' and q will have higher values. Therefore, in classII patients with protruded maxilla, or with retruded mandible, values of Wits' and q are expected to rise.

The correlation between q and Wits' with ANB angle, which is indicative of position of anterior-posterior jaws to each other, is also statistically significant. It revealed the highest level of correlation in all measured parameters of study. Therefore, the correlation between Wits' and q with position of the jaws relative to each other (ANB) has been reported more than the correlation with position of each jaw separately. This means with in-

crease in ANB, most probably, Wits' and q will show larger values too.

This condition is also observed with OJ. In other words, in addition to the skeletal relationship, antroposterior relationship of anterior teeth shows a high positive correlation with q and Wits'.

There was a highly significant correlation between q and Wits', too($r=0.828$), ($P<0.0001$), which is indicative of almost equal increase or decrease in q with Wits'.

As we know, prediction of a factor from another factor is equivalent to the square of correlation coefficient (r^2), thus, probability of exact prediction of Wits' value from q equals to $(0.828)^2$. Therefore, value of Wits' may be predicated with 70% accuracy from q. Hence, this shows that these values are interchangeable in evaluation of anteroposterior jaw relationship. However, despite the high correlation, measurement of q must also be investigated in patients with horizontal or vertical pattern of growth, so that a more accurate estimate may be obtained. This reveals the need for further study.

Conclusion

It appears that use of the perpendicular line to the Frankfort plane from A and B points is equally valuable to the use of Wits', and in case functional occlusal plane cannot be drawn or has an unusual inclination, this method may be a suitable alternative to Wits' measurement.

References

1- Jacobson A, Jacobson RL. Radiographic cephalometry from basics to 3-D imaging. 2nd ed. Chicago: Quintessence Qublishing Co; 2006, 99 - 111.

2- Reidel RA. The relation of maxillary structures to cranium in malocclusions and normal occlusion. Angle Orthod. 1952 Sep; 22(3):140-145.

3- Toylor CM. Changes in relationship of nasion, point A and point B effect on ANB. Am J Orthod. 1969 Aug; 56(2):143-63.

4- Beatty EJ. A modified technique for evaluation apical base relationships. Am J Orthod. 1975 Sep; 68(3):303-315.

5- Jenkins DH. Analysis of orthodontic deformity employing lateral cephalometric radiography. Am J Orthod. 1955 Jun;41(6):442-452.

6- Horvold E. Some biologic aspects of orthodontic treatment in the transitional dentition. Am J Orthod. 1963 Jan; 49(2):1-14.

7- Jarvinen S. An analysis of the variation of the A-N-B angle: a statistical appraisal. Am J Orthod. 1985 Feb; 87(2):144-146.

8- Jacobson A. The "Wit's" appraisal of jaw disharmony. Am J Orthod. 1975 Feb;67(2):125-138.

9- Haynes S. Chau MNY. The reproducibility and repeatability of the wit's analysis. Am J Orthod Dentofacial Orthop. 1995 Jun;107(6):640-647.

10- Bishara SE, Fahl JA, Peterson LC. Longitudinal changes in the A-N-B angle and Wit's appraisal. Am J Orthod. 1983 Aug;84(2):133-139.

11- Zupancic S, Pohar M, Farcnik F, Ovsenik M. Overjet as a predictor of sagittal skeletal relationships. Eur J Orthod. 2008 Jun;30(3):269-73.

12- Sadat-khonsari, Dathe H, Knüsel M, Hahn W, Kubein Mieenesburg D, Bauss O. Geometric influence of the sagittal and vertical apical Base relationship on the ANB angle . J Orofac Orthop. 2009 Mar;70(2):152-158.

13- Hussel W, Nanda RS. Analysis of factors affecting angle ANB. Am J Orthop. 1984 May; 85(5):411-423.

14- Twasaki H, Ishikawa H, Chowdhury L, Nakamura S , Lida J. Properties of the ANB angle and the wits appraisal in the skeletal estimation of angle's Cl III patients. Eur J Orthod. 2002 Oct; 24 (5):477-483.

15- Del Santo M Jr. Influence of occlusal plane inclination on ANB and wit's assessments of antero posterior jaw relationships. Am J Orthod Dentofacial Orthop. 2006 May; 129(5):641-648.

16- Baik CY, Ververidou M. A new approach of assessing sagittal discrepancies: The Beta angle. Am J Orthod Dentofacial Orthop. 2004 Jul; 126 (1):100-5.

17- Thayer TA. Effects of functional versus bisected occlusal planes on the Wits appraisal. Am J Orthod Dentofacial Orthop. 1990 May; 97(5):422-6.