ORIGINAL ARTICLE POJ 2020:12(1) 2-8

Correlation among three different cephalometric Jaw relationship parameters

Syeda Rabbab Hasan[a], Ulfat Bashir Raja[b]

Abstract

Introduction: The precise measurement of anteroposterior jaw relationship is an important step towards orthodontic diagnosis and treatment. The use of a single cephalometric parameter is insufficient for comprehensive cephalometric diagnosis. For the concomitant use of different parameters, the strength of correlation amongst them along with factors affecting them must be clearly understood. The objective of this study was to determine the correlation among three different cephalometric sagittal jaw relationship parameters in normodivergent vertical facial types.

Material and Methods: This cross sectional study consisted of 80 pretreatment lateral Cephalograms, that were selected irrespective of patients age and sex on the basis of normodivergent vertical facial pattern. Cephalometric landmarks were identified and sagittal jaw relationship for each subject, utilizing the three anteroposterior jaw relationship parameters namely, the ANB angle, Wits value and McNamara analysis, were recorded. Level of correlation among the three sagittal parameters were analyzed.

Results: The correlation value found between ANB angle and Wits value was 0.596, between McNamara analysis and ANB angle was 0.462 and between McNamara analysis and Wits value was 0.459. All the values found were statistically significant.

Conclusions: Moderate degree of correlation was found between angle ANB and Wits value and weak degree of correlation between McNamara analysis, angle ANB and Wits value. For appropriate clinical assessment and diagnosis of sagittal jaw relationship, it is therefore suggested to use these analyses side by side.

Keywords: Cephalometry; jaw; anatomic landmarks; diagnosis

Introduction

Cephalometric radiography is appreciated as an important tool for diagnosis, prediction and planning the orthodontic treatment.[1] The Lateral Cephalogram is the most commonly taken cephalometric radiograph, which displays numerous hard and soft tissue landmarks of craniofacial region. These anatomical landmarks on cephalometric radiographs are selected and joined to obtain lines and angles to define various relationships in sagittal and vertical planes.[2] Additionally, structural points of reference leading to angular and linear measurements may be visualized to assess the growth pattern.

The precise measurement of anteroposterior jaw relationship is an important step towards orthodontic diagnosis and treatment. Since the last few decades, many analyses have been presented to assess the spatial relationships of the jaws in sagittal dimensions.[3] Some researchers have focused on angular relationship of each jaw with

[a] Corresponding Author. BDS, FCPS, Assistant Professor, Department of Orthodontics, Islamabad Medical and Dental College, Islamabad.
Email: dr_rabbab@yahoo.com
[b] BDS, MCPS, FCPS, MHPE, Professor and Principal, Department of Orthodontics, Islamic International Dental College, Islamabad, Riphah International University.

cranial base, while others have emphasized the inter-jaw relative positioning for diagnosis of skeletal malocclusions. Those of Steiner's, Witt's appraisal[3,4] and Downs probably have gained the widest acceptance. Recently McNamara[5,6] introduced linear measurements concept of the jaws for evaluation of jaw discrepancy.

Cephalometric readings are geometrically sensitive and minor deviation can give incorrect results. Therefore, the final diagnosis should not be based on interpretation of a single parameter. It has been shown that Steiner's ANB[7] angle may prove to be imprecise in measuring the true position of maxilla and mandible with respect to Nasion as it is influenced by the rotational growth of the jaws, the sagittal and vertical position of Nasion, the degree of facial prognathism and the patient's age.[8-10] Wits appraisal being a linear measurement and involving the functional occlusal plane which is least effected by the factors affecting cranial base angulation angle may help in judging the extent of sagittal discrepancy and the reliability of ANB angle measured.[11] Studies have shown that increase and decrease in facial heights and the related changes in occlusal plane orientation, can bring discrepancies in Wits appraisal value.[8,9] To overcome these shortcomings, various other parameters utilizing different reference planes have been introduced.[3] McNamara analysis[6] is based on Frankfort's horizontal plane. However, this may also be influenced by the orientation of the horizontal plane and the rotation of jaws. The extent of jaw rotation is mostly linked to the vertical facial pattern and contributes to the unreliability of different angular and linear measurements used for diagnosis of anteroposterior jaw relationship.[9] However the angular and linear measurements when highly correlated reflect the same underlying anatomic condition in slightly different terms. As orthodontists mainly deal with faces that deviate from the normal pattern of growth and development, it is of obvious importance to investigate cephalometric diagnostic resources to improve the assessment of jaw discrepancies. Therefore, the purpose of this study was to assess the degree of agreement among three common sagittal cephalometric analyses to aid in the diagnosis of sagittal jaw relations.

Material and Methods

This Cross-sectional study included pre-treatment Lateral Cephalograms of patients reporting at the OPD of Orthodontic Department, Islamic International Dental Hospital, Islamabad.

The sampling technique was non-probability consecutive sampling. Lateral cephalometric radiographs of patients having normodivergent facial pattern with reasonable clarity and good contrast were included while those having previous history of orthodontic and / or orthopedic treatment and with craniofacial syndromes or anomalies were excluded. Total of 80 Cephalograms were selected irrespective of age and sex on the basis of above mentioned criteria.

The chief investigator traced all Cephalograms on acetate sheets using recommended lead pencil. Cephalometric landmarks were identified (Fig 1) on each of the 80 lateral Cephalograms and sagittal jaw relationship for each subject, utilizing the three antero-posterior jaw relationship parameters namely, the ANB angle, Wits value and McNamara analysis (Fig 2-4) were recorded with the help of protractor and standard scale.

The statistical analysis of the data was done by using the SPSS software Version 20. Frequencies and percentages were computed for qualitative variables including gender and group distribution. For each continuous variable (including age and all cephalometric antero-posterior jaw relationship parameters), the arithmetic mean and standard deviation was calculated. Pearson correlation coefficient was applied to see the level of correlations among the three sagittal jaw relationship parameters. Correlations were analyzed for the entire sample as a whole, as well as

separately for male and female group. In assessing the amount of correlations among the variables r value > 0.75 was considered as strong, < 0.75- 0.5 as moderate, < 0.5 – 0.25 as weak and < 0.25 as poor correlation. P value equal to or less than 0.05 was considered as statistically significant.

Results

Out of total 80 patients 62 were female (Figure 6). The mean age of the sample as a whole was 18 years (S.D 4.1). The sample showed a greater female composition, comprising 77.5% of the total sample population. The arithmetic mean and standard deviations for all cephalometric anteroposterior jaw relationship parameters assessed in the sample are shown in Table I.

The sagittal classification (Class I, II and III) for the entire sample was derived by using the three sagittal jaw relationship parameters. Each parameter showed different number of cases in each skeletal class (Table II). McNamara showed the highest percentage of Class III cases, whereas ANB angle and Wits value showed the highest frequency of patients in Class I and Class II group, respectively in comparison with other parameters.

Pearson correlation coefficient was used to compare the three cephalometric anteroposterior jaw relationships parameters (Table III). Each of the three sets of variables exhibited statistically significant correlation ($p<0.01$). ANB angle and Wits appraisal showed moderate level of correlations, whereas Wits appraisal and McNamara, and ANB angle and McNamara showed weak level of correlations. Table IV-V show correlation in the male and female groups.

Table I: Means and Standard Deviation of sagittal jaw relationship parameters in the sample

	Mean	S.D	Minimum	Maximum
ANB angle	3.98°	3.08°	-5°	10°
Wits value	2.64 mm	4.66 mm	-11 mm	15.70 mm
McNamara analysis	6.43 mm	5.25 mm	-10.30 mm	21.90 mm

Table II: Distribution of cases into class I, II and III according to ANB angle, Wits value, and McNamara analysis in the sample

Class	ANB angle		Wits value		McNamara analysis	
	frequency	Percentage	frequency	percentage	frequency	percentage
1	22	27.5	5	6.25	12	15
2	46	57.5	59	73.75	42	52.5
3	12	15	16	20	26	32.5
Total	80	100	80	100	80	100

Table III: Correlation coefficients (r) for the three anteroposterior jaw relationship parameters in the sample as a whole

	Wits value	McNamara analysis
ANB angle	0.596**	0.462**
Wits value		0.459**
McNamara analysis		

** Correlation (r) is significant at the 0.01 level

Table IV: Correlation coefficients (r) for the three anteroposterior jaw relationship parameters in the male group

	ANB	Wits	McNamara
ANB		0.705**	0.417
Wits			0.349
McNamara			

** Correlation (r) is significant at the 0.01 level

Table V: Correlation coefficients (r) for the three anteroposterior jaw relationship parameters in the female group

	ANB	Wits	McNamara
ANB		0.493**	0.497**
Wits			0.507**
McNamara			

** Correlation (r) is significant at the 0.01 level

Discussion

Over the last 60 years, the sagittal relationship of the jaws has been defined using angular measurements or linear distances between the reference planes constructed by joining different craniofacial landmarks and points e.g. A and B, which represent anterior limits of maxilla and manidble.[1-2] Among numerous measurements employed in the assessment of sagittal jaw relationship described in the literature, ANB angle and Wits value are still recognized as important skeletal sagittal discrepancy indicators. Although angle ANB has certainly stood the test of time since its introduction by Riedel[12] in 1952, several authors[13-19] have stated that ANB angle is influenced by numerous external factors and thus it has been suggested that this angle should be used in conjunction with other measurements to ensure accuracy.[9,20-21]

In present study, we correlated the angle ANB with Wits value and McNamara analyses. Although correlation amongst angle ANB and Wits value has been determined by several other studies, only few have compared angle ANB and Wits value with McNamara analyses. For the study results to gain clinical applicability, we incorporated a study sample comprising of different malocclusion groups in the sagittal plane. However, in order to reduce the influence of vertical facial pattern on sagittal classification, only normal angle cases were included.

Looking at the sample stratification into different classes at a glance, there seemed to exist a preponderance for Class II malocclusion in the study sample, which is a phenomenon usually encountered in most orthodontic practices[22] with Class II malocclusion patients being the most common type amongst the malocclusion groups to seek orthodontic treatment as stated by Erum et al and Hamid et al.[23-24] In contrast a few local studies reported Angles class I to be the most common type among the local popultion.[25-26] This could be because of diversity in the population group[25] and the difference in the population from which the sample collection was done.[26]

Although our sample was predominantly Skeletal Class II, but each parameter individually showed different number of cases in each skeletal class. Maximum number of cases in class III group were identified by McNamara analysis, whereas the ANB angle and Wits value displayed the highest percentage of patients in Class I and Class II group respectively. This is in contrast to the results of Erum et al[27] and Nanda[28] who found Wits value to be skewed towards Class III.

In common practice, angle ANB and Wits appraisal are frequently employed methods for determining sagittal dysplasia. Tanaka et al[9] reason the possibility of effect of facial form on correlation between ANB and Wits still exist. Hence in the present study, in order to rule out the effect of facial pattern on correlation amongst sagittal parameters, we only selected patients with normodivergent facial pattern.

Usually it is considered that ANB and Wits should have good degree of agreement if they are not influenced by the facial types. However, correlation analyses in our study revealed a moderate degree of correlation between angle ANB with Wits value ($r = 0.569$) in the combined sample, while a weak degree of correlation ($r < 0.5$) of McNamara analysis with Wits value and ANB angle, although all correlations were found statistically significant.

Polk[29] in an attempt to precisely quantify the treatment difficulty, studied the utility of the ANB angle and Wits appraisal in diagnosis and treatment planning and concluded that although these two sagittal jaw relationship parameters are not 100% accurate in determining sagittal jaw discrepancy, using them both side by side can increase the validity of the diagnosis. Oktay[21] and Qamaruddin[22] reported a strong correlation between ANB and Wits, contrary to the moderate and weak correlation between them

that has been found in our study and in several other studies respectively.[17-18,30-31]

Similar to the results of our study, Ishikawa et al[20] while evaluating interchangeability among seven parameters in a sample of 44 normal occlusion subjects, found that ANB angle had moderate correlation (r = 0.57) with the Wits appraisal. A similar study by Bishara et al[17] (1983) also found significant correlation amongst the angle ANB and Wits value where the correlations (0.63 in males and 0.56 in females) were somewhat similar to the results of our study (0.7 in males and 0.49 in females).

Previously, to our knowledge no study has correlated Wits value with McNamara analysis. We attempted to correlate them because of routine use of these parameters as our diagnostics for sagittal relationship, so that if a good correlation is established between the two parameters they can be used interchangeably. However, we found a weak correlation (r = 0.46) suggesting their simultaneously use for diagnosis. The possibility for the weak correlation amongst the two analyses could be the difference in landmarks and reference planes utilized by them, as Wits is dependent on the functional occlusal plane and McNamara analysis is dependent on the Frankfort horizontal plane.[2]

To our knowledge the only comparative study on Steiner's ANB angle and McNamara analysis was performed by Oria et al in which he determined the position of bone bases with the help of these two analyses on 51 patients and revealed substantial similarity of the two techniques.[32] This is in contrast to the results of our study in which we found a weak correlation (r = 0.462) between the two analyses, suggesting simultaneous use of both analyses for determining the sagittal jaw relationship.

Our study sample consisted of a variety of malocclusions in the sagittal dimensions, and hence represented the customary patient population presenting to the orthodontic practice. Our findings suggest that in order to increase the validity of diagnosis, these three parameters for determining the sagittal jaw relationship should be used in combination so that they can compensate for each other and avoid misinterpretation.

Conclusions

A moderate degree of correlation exists between angle ANB and Wits value. Correlation of McNamara analysis with angle ANB and Wits value has a weak correlation. All correlations found were statistically significant. Lastly it can be concluded that for an appropriate clinical assessment and diagnosis of sagittal jaw relationship these analyses should be used concomitantly.

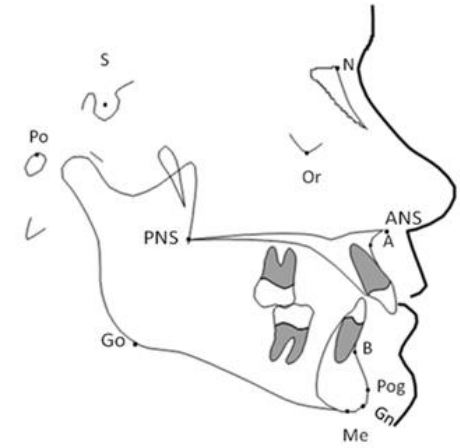

Figure 1

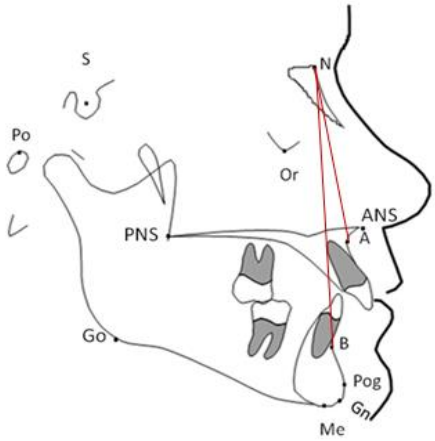

Figure 2

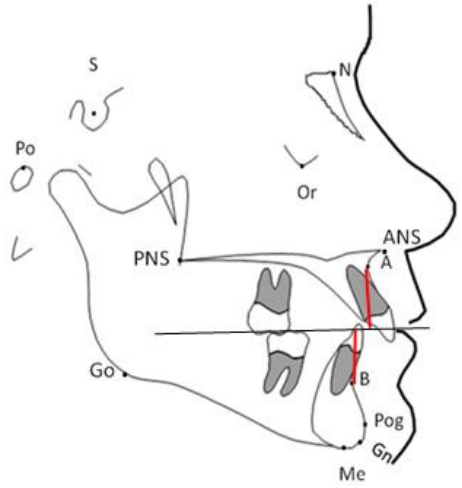

Figure 3

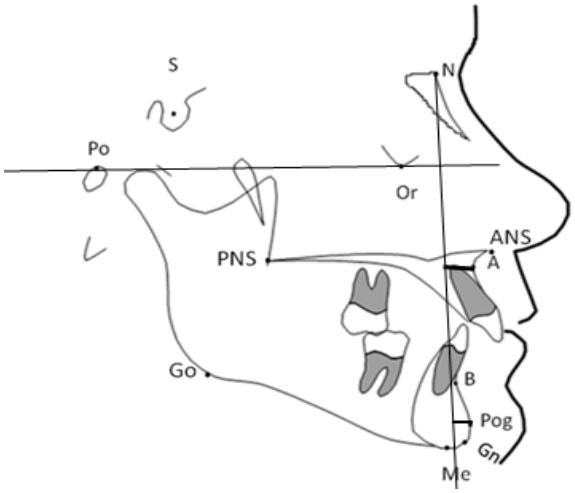

Figure 4

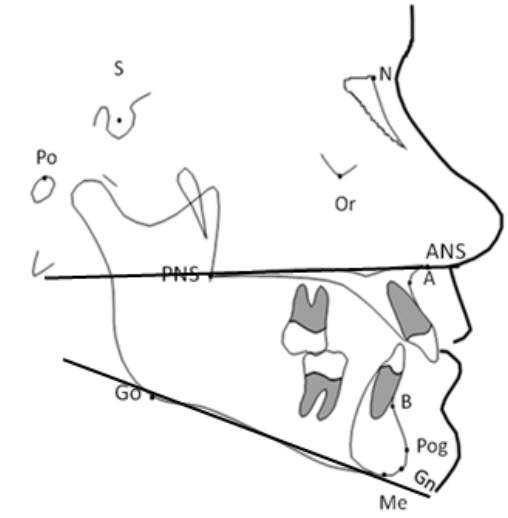

Figure 5

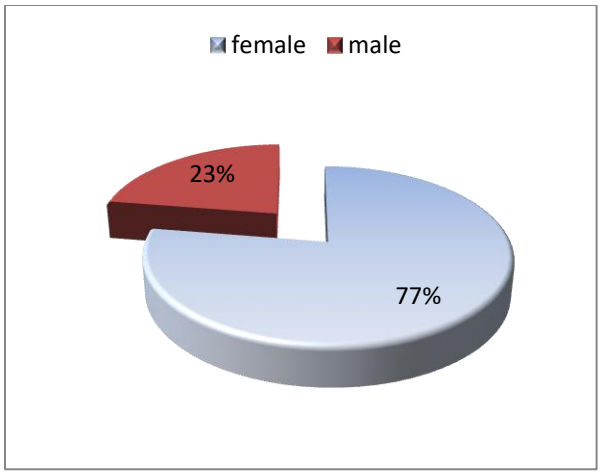

Figure 6: Gender distribution

References

1. Mah JK, Hatcher D. Craniofacial Imaging in Orthodontics. In: Graber TM, Vanarsdall RL, Vig KM, editors. Orthodontics: current principles and techniques. 4th ed. St Louis: Elsevier; 2005. p. 71-100
2. Jacobson A, Jacobson RL. Radiographic Cephalometry: from basics to 3-D imaging. 2nd ed. Chicago: Quintessence Publishing Co; 2006
3. Ahmed M, et al. Diagnostic validity of different cephalometic analysis for assessment of sagittal skeletal pattern. Dental Press J Orthod 2018;23(5):75-81
4. Zhou L, Mok CW, Hagg U, McGrath C, Bendeus M, Wu J. Anteroposterior dental arch and jaw-base relationship in a population sample. Angle Orthod 2008;78:1023-9
5. Anderson G, Fields HW, Beck M, Chacon G, Vig KW. Development of cephalometric norms using a unified facila and dental approach. Angle Orthod 2006;76:612-8
6. Jacobson A. McNamara Analysis. In: Jacobson A, Jacobson RL, editors. Radiographic Cephalometry. 2nd ed. Chicago: Quintessence Publishing Co; 2006.p. 113-24
7. Anwar N, Fida M. Evaluation of dentoalveolar compensation in skeletal class II malocclusion in a Pakistani University Hospital setting. J Coll Physicians Srug Pak 2009;19:11-6
8. Del Santo M, Jr. Influence of occlusal plane inclination on ANB and Wits assessment of anteroposterior jaw relationships. Am J Orthod Dentofacial Orthop 2006;129:641-8
9. Tanaka JL, Ono E, Filho Medici E, Cesar de Moraes L, Cezar de Melo Castilho J, Lenoelli de Moraes ME. Influence of facial pattern on ANB, AF-BF, and Wits appraisal. World J Orthod 2006;7:360-75

10. Sadat-Khonsari R, Dathe H, Knosel M, Hahn W, Kubein-Messenburg D, Bauss O. Geometric influence of the sagittal and vertical apical base relationship on the ANB angle. J Orofacial Orthop 2009;70:152-8
11. Jacobson A. Wits Appraisal. In: Jacobson A, Jacobson RL, editors. Radiographic Cephalometry: From Basics to 3-D Imaging. Chicago: Quintessence Publishing Co;2006. p.99-112
12. Riedel RA. The relation of maxillary structures to cranium in malocclusion and in normal occlusion. Angle Orthod 1952;22:142-5
13. Proffit WR, Sarver DM, Ackerman JL. Orthodontic diagnosis: the development of a problem list. In: Proffit WR, Fields HW, Sarver DM, editors. Contemporary Orthodontics. Missouri: Elsevier;2007.p.201-28
14. Freeman RS. Adjusting A-N-B angles to reflect the effect of maxillary position. Angle Orthod 1981;51:162-71
15. Hussels W, Nanda RS. Analysis of factors affecting angle ANB. Am J Orthod 1984;85:411-23
16. Staley RN. Cephalometic analysis. In: Bishara SE, editor. Textbook of Orthodontics. Philadelphia: Saunders; 2001.p. 113-25
17. Bishara SE, Fahl JA, Peterson LC. Longitudinal changes in the ANB angle and Wits appraisal: clinical implications. Am J Orthod 1983;84:133-9
18. Chang HP. Assessment of anteroposterior jaw relationship. Am J Orthod Dentofacial Orthop 1987;92:117-22
19. Enlow DH. Handbook of facial growth. 2nd ed. Philadephia: Saunders; 1982
20. Ishikawa H, Nakamura S, Iwasaki H, Kitazawa S. Seven parameters describing anteroposterior jaw relationships: postpubertal prediction accuracy and interchangeability. Am J Orthod Dentofacial Orthop 2000;117:714-20
21. Oktay H. A comparison of ANB, WITS, AF-BF, and APDI measurements. Am J Orthod Dentofacial Orthop 1991;99:122-8
22. Qamaruddin I, et al. Comparison of popular sagittal cephalometric analyses for validity and reliability. Saudi Dent J. 2018;30(1):43-6
23. Gul e E, Fida M. Pattern of malocclusion in orthodontic patient: a hospital based study. J Ayub Med Coll Abbottabad 2008;20:43-7
24. Hamid WU, Asad S. Prevalence of skeletal components of malocclusion using composite cephalometric analysis. Pak Oral Dental J 2003;23:137-44
25. Shehzad S, Alam J, Ashfaq M. An analysis of orthodontic patients treated during 2001 at Khyber Collage of Dentistry Peshawar. Pakistan Oral & Dent Jr 2002;22:149-50
26. Afzal A, Ahmed I, Vohra F. Frequency of malocclusion in a sample taken from Karachi population. Ann Abbasi Shaheed Hosp Karachi Med Dent Coll 2004;9:588-91
27. Gul e E, Fida M. A comparison of cephalometric analyses for assessing sagittal jaw relationship. J Coll Physicians Surg Pak 2008;18:679-83
28. Nanda RS, Merrill RM. Cephalometric assessment of sagittal relationship between maxilla and mandible. Am J Orthod Dentofacial Orthop 1994;105:328-44
29. Polk CE, Buchanan D. A new index for evaluating horizontal skeletal discrepancies and predicting treatment outcomes. Am J Orthod Dentofacial Orthop 2003;124:663-9
30. Jarvinen S. An analysis of the variation of the ANB angle: a statistical appraisal. Am J Orthod 1985;87:144-6
31. Rushton R, Cohen A, Linney A. The relationship and reproducibility of angle ANB and the Wits appraisal. Br J Orthod 1991;18:225-31
32. Oria A, Schellino E, Massaglia M, Fornengo B. A comparative evaluation of Steiner's and NcNamara's methods for determining the position of the bone bases. Minerva Stomatol 1991;40:381-5