HU Revista
Artigo Original

Correlations between ANB, Wits and soft-tissue facial profile in a Brazilian population sample

Correlações entre o ANB, Wits e perfil facial de tecido mole em uma amostra populacional brasileira

Rodrigo César Santiago[1]
Marcio José da Silva Campos[2]
Robert Willer Farinazzo Vitral[2]
Jocimara Domiciano Fartes de Almeida Campos[3]
Fernanda Ramos de Faria[3]
Lincoln Issamu Nojima[4]
Eduardo Franzotti Sant'Anna[4]

[1]Unidade de Cabeça e Pescoço, Hospital Universitário da Universidade Federal de Juiz de Fora, Empresa Brasileira de Serviços Hospitalares, Juiz de Fora, MG, Brasil.

[2]Universidade Federal de Juiz de Fora, Juiz de Fora, MG, Brasil.

[3]Centro Universitário Estácio, Juiz de Fora, MG, Brasil.

[4]Universidade Federal do Rio de Janeiro, Rio de Janeiro, RJ, Brasil.

✉ **Marcio José Campos**

R. Giuseppe Verdi, 111, Juiz de Fora, Minas Gerais
CEP: 36036-643
drmarciocampos@hotmail.com

Submetido: 10/08/2024
Aceito: 04/10/2024

ABSTRACT

Introduction: The ANB angle and the Wits appraisal are common cephalometric tools for assessing anteroposterior jaw discrepancies. Assessment of a patient's anatomy in the anteroposterior disharmony of the maxillary and mandibular should not be limited to hard-tissue relationships, but should also consider soft tissue involvement, such as the soft-tissue facial profile angle. **Objective:** To evaluate the correlations between sagittal skeletal relationships established through ANB angle and Wits appraisal and to evaluate the soft-tissue facial profile angle, assessed by the G-Sn-Pog' angle. **Material and Methods:** The sample consisted of 300 individuals (129 male and 171 female). The ANB angle, the Wits appraisal, and by the G-Sn-Pog' angle were obtained through lateral cephalograms. The facial profile was categorized into three groups. The correlation coefficients between ANB angle and Wits appraisal and between the soft-tissue facial profile angle and skeletal pattern were evaluated. **Results:** A significant correlation ($p < .001$) was observed between ANB angle and Wits appraisal ($r = .738$), between G-Sn-Pog' and ANB angle ($r = -.708$), and between G-Sn-Pog' and Wits appraisal ($r = -.586$). When assessed separately according to different groups of soft-tissue facial profiles, there was a weak correlation between ANB and Wits assessment in the low soft-tissue facial profile angle subjects (Group II), and a moderate correlation in the high soft-tissue facial profile angle subjects (Group III). **Conclusion:** The correlation between ANB angle and Wits was moderate to high, except in Group II soft-tissue facial profile subjects.

Keywords: Cephalometry; Jaw Relation Record; Maxilla; Mandible; Orthodontics.

RESUMO

Introdução: O ângulo ANB e a avaliação de Wits são métodos cefalométricos comuns para avaliar as discrepâncias anteroposteriores da mandíbula. A avaliação da anatomia de um paciente na desarmonia anteroposterior da maxila e da mandíbula não deve ser limitada às relações dos tecidos duros, mas também deve considerar o envolvimento dos tecidos moles, como o ângulo do perfil facial dos tecidos moles. **Objetivo:** Avaliar as correlações entre as relações esqueléticas sagitais estabelecidas por meio do ângulo ANB e da avaliação de Wits e avaliar o ângulo do perfil facial dos tecidos moles, avaliado pelo ângulo G-Sn-Pog'. **Material e Métodos:** A amostra foi composta por 300 indivíduos (129 do sexo masculino e 171 do sexo feminino). O ângulo ANB, a avaliação de Wits e o ângulo G-Sn-Pog' foram obtidos por meio de telerradiografias laterais. O perfil facial foi categorizado em três grupos. Foram avaliados os coeficientes de correlação entre o ângulo ANB e a avaliação de Wits e entre o ângulo do perfil facial dos tecidos moles e o padrão esquelético. **Resultados:** Foi observada correlação significativa ($p < 0,001$) entre o ângulo ANB e a avaliação de Wits ($r = 0,738$), entre G-Sn-Pog' e o ângulo ANB ($r = -,708$) e entre G-Sn-Pog' e a avaliação de Wits ($r = -,586$). Quando avaliados separadamente de acordo com os diferentes grupos de perfis faciais de tecidos moles, houve uma correlação fraca entre a avaliação ANB e Wits nos indivíduos com ângulo do perfil facial dos tecidos moles baixo (Grupo II), e uma correlação moderada nos indivíduos com ângulo do perfil facial dos tecidos moles alto (Grupo III). **Conclusão:** A correlação entre o ângulo ANB e Wits foi moderada a alta, exceto nos indivíduos de perfil facial de tecido mole do Grupo II.

Palavras-chave: Cefalometria; Registo da Relação Maxilomandibular; Maxila; Mandíbula; Ortodontia.

INTRODUCTION

Orthodontic decisions depend on the correct diagnosis. Treatment objectives and plans are deeply, although not exclusively, established by cephalometric information.[1] To accurately determine jaw relationships, cephalometric analysis is necessary because two different malocclusions can appear alike when observing only cast models. Nonetheless, careful cephalometric analysis can show that the cases are very different.[2] The anteroposterior (AP) relationship of the maxillary and mandibular apical bases is an important parameter evaluated during diagnosis.[3,4] Usually, the most common cephalometric tools for assessing AP jaw discrepancies are ANB angle[5] and the Wits appraisal,[6] and the combination of them can diagnose skeletal discrepancies and address treatment strategies.[7,8]

Hussels and Nanda[9] and Jacobson[10] reported inherent geometric factors that affect the validity of these cephalometric parameters proposed to describe the anteroposterior jaw relationship. The value of the ANB is subject to many variables in the dentofacial complex, such as variance in the length of the cranial base and/or rotation of the jaws,[6,8,11,12] while the Wits measurement depends on the correct location or representation of the occlusal plane.[11,13,14]

ANB and Wits appraisal should have some correspondence given that they assess the same skeletal disharmony. However, the correlation between them is not as strong as expected and suggests weakness in at least one assessment tool.[1,8,15,16] When there is a difference in the jaw relationship classification between the two parameters, it is difficult to know on which parameter to base the diagnosis.[17] Almaqrami et al[7] and Ahmed et al[18] concluded that ANB is a more reliable indicator of the skeletal anteroposterior relation, while Tiwari et al[19] found that it shows less validity for comparison in any age group and in Angle's Class I discrepancies.

Assessment of a patient's anatomy in the anteroposterior disharmony of the maxillary and mandibular should not be limited to hard-tissue relationships, but should also consider the involvement of the soft tissues.[20,21] There is a good correlation between facial soft-tissue profile and AP jaw relationships.[22,23]

The soft-tissue facial profile angle (STFP) is a soft-tissue cephalometric measurement formed by connecting the soft tissue glabella, subnasale, and soft tissue pogonion and could be adequate for standard diagnoses and treatment planning in most orthodontic patients.[24,25] The STFP represents aesthetic facial effects on individuals preferably when comparing it with cephalometric measurements based on skeletal structures such as ANB and Wits.

The aim of this study was to analyze the correlation between ANB, Wits appraisal, and STFP angle, and to estimate the anteroposterior skeletal relationships influences on soft-tissue facial profile.

MATERIAL AND METHODS

This cross-sectional study was approved by the Ethics on Research Committee at Federal University of Juiz de Fora (0076.0.239.000-09) and the subjects voluntarily agreed to participate.

This analysis was done with lateral cephalogram of 300 Caucasian Brazilian subjects, 129 male (43%), and 171 female (57%), mean age 20.0 years (±7.14), who made the initial records for orthodontic treatment. The cephalometric radiographs were taken on the same X-ray equipment, at the same distance and intensity. The sample was selected according to the following criteria: complete permanent dentition; no supernumerary teeth; no previous orthodontic treatment; and absence of congenital malformations and craniofacial deformities.

The cephalometric reference values of anteroposterior jaw-base relationship and facial profile were assessed using ANB,[5] Wits appraisal,[6] and the soft-tissue facial profile (STFP) (Figure 1).[22]

The soft-tissue facial profiles were categorized into 3 groups according to the mean and standard deviation (SD) of STFP, as following: Group I, defined as values within range of mean value of the sample ±1 SD (STFP= 156.7° to 171.08°); Group II, defined as less than mean values -1 SD (STFP <156.7°); and Group III, defined as values greater than mean values +1 SD (STFP >171.08°). Thereafter, the sample was allocated to the three groups.

For operator calibration analysis, the reproducibility of ANB, Wits, and STFP was assessed at fifty lateral cephalometric radiographs, traced twice at one-week intervals and the Intraclass Correlation Coefficient (ICC) was used to compare the 2 assessments.

The difference between genders was evaluated with two-sample Student's t-tests. One-way analysis of variance (ANOVA) and Tukey's post hoc test were used to assess the variations in STFP, ANB, and Wits according to groups. Correlation between anteroposterior jaw-base relationship parameters (ANB and Wits) and STFP was calculated using a Pearson correlation test. Linear regression analysis was performed to estimate the influence of ANB and Wits on STFP. The significance level used was $\alpha = 0.05$ and all statistical analysis was performed using SPPS version 23.0 (SPSS Inc, Chicago, USA).

The power of the sample (n= 300) for this study was 97.8% ($1-\beta = 0.978$), with a type β error of 0.05. A minimum effect of 0.30 and $\beta/\alpha = 1$ were considered.

RESULTS

The calibration analysis showed no significant differences between the 2 assessments for all variables

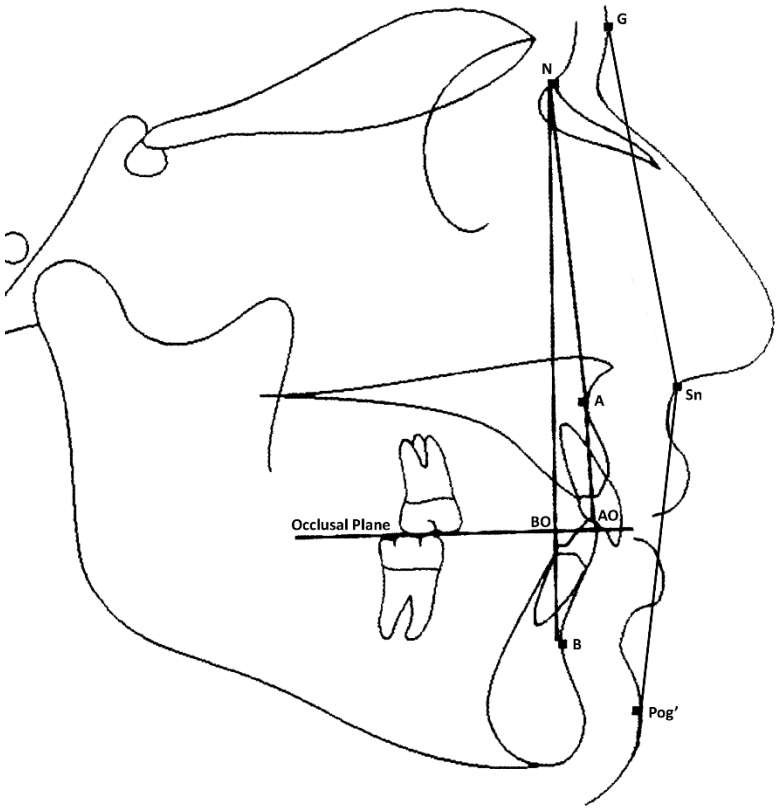

Figure 1: Cephalometric measurements: ANB, Wits appraisal [AO-BO], and soft-tissue facial profile [G-Sn-Pog'].

(ICC >0.85). There was no significant difference between genders for all variables, and the male and female data were pooled for each of the measurements.

The mean value of STFP for the sample was 163.89°, with a standard deviation of 7.19°, with group I being defined as values between 156.7° and 171.08°, group II with values less than 156.7° and group III with values greater than 171.08°. Descriptive statistics for three groups are given in Table 1. All variables showed significant differences between groups (Figures 2 and 3).

In the evaluated sample, the STFP exhibited a significant negative correlation with the ANB and Wits values, when considering the entire sample and each group separately, with the exception of the correlation with Wits in group II. ANB and Wits values showed a significant positive correlation in all comparisons performed (Table 2).

For the total sample, anteroposterior jaw-base relationship parameters were found to be a significant predictor of STFP, demonstrated by linear regression (Table 3).

DISCUSSION

Orthodontic treatment objectives and plans, while not exclusively, are deeply driven by cephalometric decisions.[1] There is an intensive search for new and better cephalometric and non-cephalometric tools to assess anteroposterior jaw-base relationships,[26-29]

Table 1: Descriptive statistics for Groups I, II, and III, and total sample.

		Variables		
		STFP (°)	ANB (°)	Wits (°)
	N	Mean (SD)	Mean (SD)	Mean (SD)
Group III (STFP >171.08°)	39	177.41 (5.46)	-0.42 (2.65)	-3.69 (4.67)
Group I (STFP= 156.7° to 171.08°)	218	163.51 (3.72)	3.08 (2.09)	0.87 (3.14)
Group II (STFP <156.7°)	44	154.13 (2.08)	6 (2.01)	3.81 (2.70)
Total sample	300	163.89 (7.19)	3.07 (2.73)	0.72 (3.85)

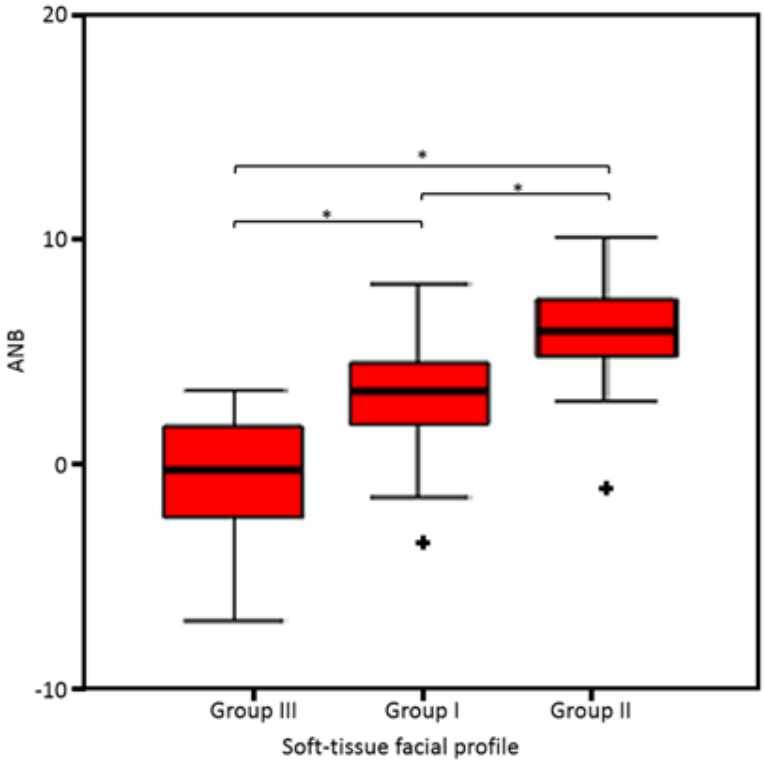

Figure 2: Box-plot of mean values for ANB in three soft-tissue facial profiles (Groups I, II, and III).
*Statistically significant differences.

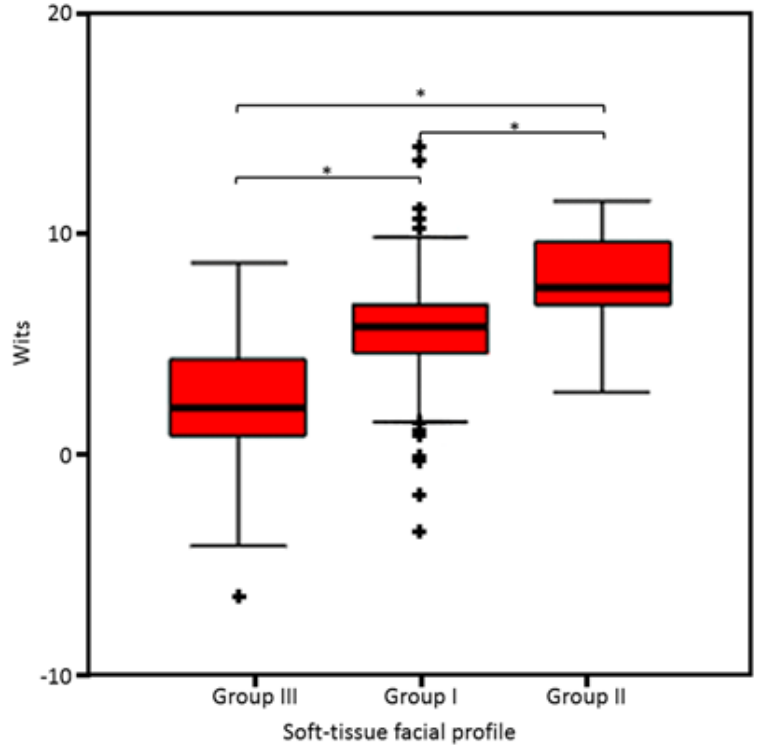

Figure 3: Box-plot of mean values for Wits appraisal in three soft-tissue facial profiles (Groups I, II, and III).
*Statistically significant differences.

Table 2: Pearson correlation between STFP, ANB, and Wits for total sample, and separately according to groups.

	ANB (°)	Wits (mm)
Total sample		
Wits	0.738**	-
STFP	-0.708**	-0.586**
Group III		
Wits	0.719**	-
STFP	-0.523**	-0.426**
Group I		
Wits	0.653**	-
STFP	-0.449**	-0.318**
Group II		
Wits	0.309*	-
STFP	-0.322*	-0.162

Correlation is significant at p <0.05* and p <0.01**.

Table 3: Linear regression (r^2) with the percentage of explained variability of STFP (dependent variable) when predicting using ANB and Wits (independent variables).

Dependent variable	Independent variables			
	ANB		Wits	
	%	(r^2)	%	(r^2)
STFP	50.2*	0.502	34.4*	0.344

*Significant at p <0.01.

as many orthodontic decisions depend on correct cephalometric diagnosis.

The subject's jaw-base relationships and soft-tissue facial profile were classified according to a method previously reported in the literature.[30] Thus, we tried to eliminate classification bias by means of a representative sample.

In a previous study with another Brazilian sample,[1] the mean values reported for ANB and Wits were respectively 27.7% and 19.5% higher than in this study, but about 75% of the patients had Class II malocclusion. In the present study, 63.3% of the patients had Class I malocclusion, which could explain the difference. It is important to remember, for treatment planning, that these values change according to gender and ethnic group, so it is necessary to identify the mean average features of a specific group.[31]

The mean value for G-Sn-Pog' angle reported in the literature for Class I facial profile subjects is 168.7°,[22] which is approximately 4° lower than the average range of profile angle for Group I of this study. This difference may be attributed to intrinsic characteristics of the population sample, as Brazilian people seem to have a more convex profile than Caucasians.

The literature reports different levels of correlation between ANB and Wits, ranging between 0.65 and 0.84.[1,8,18,25,32] This range includes the correlation coefficient for our sample of 300 subjects. Although close to the maximum values as reported previously, this suggests a moderate correlation between ANB and Wits. In fact, the correlation between them is not as strong as expected and suggests weakness in at least one assessment tool.

Sagittal and vertical jaw discrepancies are partly reflected in the face and a significant correlation had been previously reported between cephalometric and soft-tissue measurements of maxillomandibular anteroposterior discrepancies.[19,23,24,33] In the present study, the general view of correlation between G-Sn-Pog' and skeletal parameters showed a higher correlation with ANB when compared with Wits appraisal. This was expected because both ANB and G-Sn-Pog' reflect the jaw-base relationship on sagittal plane taking the skull base as a reference,[2,23,24] while the Wits appraisal is measured on the occlusal plane. The negative correlation values are related to the fact that the G-Sn-Pog' angle increases as ANB and Wits values decrease, and vice versa.

When assessing STFP-ANB and STFP-Wits correlation within groups, the lowest values were observed between STFP and ANB and between STFP and Wits for group II. This may be explained by the fact that subjects in group II showed the highest mean value for ANB. These values are characteristic of skeletal Class II malocclusions, which can be hidden due to dental compensation underestimating the aesthetic component. The highest correlation values were observed between STFP-ANB and between STFP-Wits for group III subjects. The subjects in group III showed a negative value for ANB and Wits, which are associated with skeletal Class III malocclusions, where the aesthetic component is significantly affected.

The research model of this study detected a clear association between the soft-tissue facial profile and the lack of consistency between ANB and Wits. When analyzing the correlation within the soft-tissue facial profile groups (I, II, and III), the highest correlation between ANB and Wits appraisal was observed in group III subjects. The lowest correlation between ANB and Wits was observed in group II subjects. These findings conform with the literature,[1] where a lack of consistency between ANB and Wits assessment in high occlusal plane angle patients was demonstrated. Patients with high occlusal plane angle showed the highest ANB mean values in earlier research,[1] as with subjects of group III in this research.

With linear regression, part of the natural variability of one variable can be explained with knowledge of the other.[2,34] In this study, by knowing the ANB and Wits appraisal values, a prediction of the STFP values within a determined range can be made. The linear regression results demonstrated that ANB can predict the STFP values more precisely when compared

with Wits appraisal.[34]

The findings of this study demonstrated that when there is a difference in anteroposterior jaw-base discrepancies assessment, there is a better association between ANB and the soft-tissue facial profile. It also suggests that the STFP could be an important auxiliary tool during orthodontic diagnosis. The soft-tissue analysis should not, of course, take the place of a comprehensive clinical examination of the patient.

CONCLUSION

The correlation between ANB angle and Wits was moderate to high, except in Group II soft-tissue facial profile subjects. The results of this study suggest that anteroposterior sagittal discrepancies reflect directly on the face, and the soft-tissue facial profile pattern is a more valid reflection of skeletal anteroposterior jaw-base relationship when assessed by ANB than through Wits appraisal.

CONFLICT OF INTEREST

The authors declare that there was no conflict of interest.

REFERENCES

1. Del Santo M. Influence of occlusal plane inclination on ANB and Wits assessment of anteroposterior jaw relationships. Am J Orthod Dentofacial Orthop. 2006; 129(5):641-8.

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

3. Al-Hamlan N, Al-Eissa B, Al-Hiyasat AS, Albalawi FS, Ahmed AE. Correlation of dental and skeletal malocclusions in sagittal plane among Saudi orthodontic patients. J Contemp Dent Pract. 2015; 16(5):353-9.

4. Palla A, Kumar DN, Mandava P, Shamnur N, Kumar GNA, Reddeepa SK et al. Comparative assessment of sagittal skeletal discrepancy: a cephalometric study. J Clin Diagn Res. 2015; 9(4):38-41.

5. Riedel RA. An analysis of dentofacial relationships. Am J Orthod. 1957; 43(2):103-19.

6. Jacobson A. The "wits" appraisal of jaw disharmony. Am J Orthod. 1975; 67(2):125-38.

7. Almaqrami BS, Alhammadi MS, Cao B. Three dimensional reliability analyses of currently used methods for assessment of sagittal jaw discrepancy. J Clin Exp Dent. 2018; 10(4):e352-60.

8. Bishara SE, Fahl JA, Peterson LC. Longitudinal changes in the ANB and Wits appraisal: clinical implications. Am J Orthod. 1983; 84(2):133-9.

9. Hussels W, Nanda RS. Analysis of factors affecting angle ANB. Am J Orthod. 1984; 85(5):411-23.

10. Jacobson A. Update on the Wits appraisal. Angle Orthod. 1988; 58(3):205-19.

11. Aldrees AM. Pattern of skeletal and dental malocclusions in Saudi orthodontic patients. Saudi Med J. 2012; 33(3):315-20.

12. Tanaka JL, Ono E, Filho Medici E, Moraes LC, Castilho JCM, Moraes MEL. Influence of the facial pattern on ANB, AF-BF, and Wits appraisal. World J Orthod. 2006; 7(4):369-75.

13. Rushton R, Cohen AM, Linney AD. The relationship and the reproducibility of ANB and the Wits appraisal. Br J Orthod. 1991; 18(3):225-31.

14. Sherman SL, Woods M, Nanda RS, Currier GF. The longitudinal effects of growth on the Wits appraisal. Am J Orthod Dentofacial Orthop. 1988; 93(5):429-36.

15. Polk CE, Buchanan D. A new index for evaluating horizontal skeletal discrepancies and predicting treatment outcomes. Am J Orthod Dentofacial Orthop. 2003; 124(6):663-9.

16. Zamora N, Cibrián R, Gandia JL, Paredes V. Study between ANB and Wits appraisal in cone beam computed tomography (CBCT). Med Oral Patol Oral Cir Bucal. 2013; 18(4):e725-32.

17. Iwasaki H, Ishikawa H, Chowdhury L. Properties of the ANB and Wits appraisal in the skeletal estimation of Angle's Class III patients. Eur J Orthod. 2002; 24(5):477-83.

18. Ahmed M, Shaikh A, Fida M. Diagnostic validity of different cephalometric analyses for assessment of the sagittal skeletal pattern. Dental Press J Orthod. 2018; 23(5):75-81.

19. Tiwari R, Shyagali TR, Gupta A, Joshi R, Tiwari A, Sen P. Predictability and reliability of different anterio-posterior skeletal discrepancy indicators in different age groups: a cephalometric study. J Clin Diagn Res. 2016; 10(9):ZC80-4.

20. Bergman RT. Cephalometric soft tissue facial analysis. Am J Orthod Dentofacial Orthop. 1999; 116(4):373-89.

21. Jazmati HM, Ajaj MA, Hajeer MY. Assessment of facial soft tissue dimensions in adult patients with different sagittal skeletal classes using cone beam computed tomography. J Contemp Dent Pract. 2016; 17(7):542-8.

22. Bittner C, Pancherz H. Facial morphology and malocclusions. Am J Orthod Dentofacial Orthop. 1990; 97(4):308-15.

23. Ferrario VF, Sforza C, Poggio, CE, Serrao G. Facial three-dimensional morphometry. Am J Orthod Dentofacial Orthop. 1996; 109(1):86-93.

24. Burstone CJ. The integumental profile. Am J Orthod. 1958; 44(1):1-25.

25. Ferrario VF, Serrao G, Ciusa V, Morini M, Sforza C. Cephalometric and in vivo measurements of maxillomandibular anteroposterior discrepancies: a preliminary regression study. Angle Orthod. 2002; 72(6):579-84.

26. Gupta P, Singh N, Tripathi T, Gopal R, Rai P. Tau angle: a new approach for assessment of true sagittal maxillomandibular relationship. Int J Clin Pediatr Dent. 2020; 13(5):497-500.

27. Gupta S, Tandon P, Singh GP, Shastri D. Comparative assessment of cephalometric with its analogous photographic variables. Natl J Maxillofac Surg. 2022; 13(1):99-107.

28. Maspero C, Cenzato N, Inchingolo F, Cagetti MG, Isola G, Sozzi D et al. The maxilla-mandibular discrepancies through soft-tissue references: reliability and validation of the anteroposterior measurement. Children. 2023; 10(3):459.

29. Sreenivasagan S, Sivakumar A. FSA angle: a soft tissue approach for assessing sagittal skeletal discrepancy. Int J Clin Pediatr Dent. 2021; 14(Suppl 1):S54-6.

30. Zhou L, Mok CW, Hagg U, McGrath C, Bendeus M, Wu J. Anteroposterior dental arch and jaw-base relationships in a population sample. Angle Orthod. 2008; 78(6):1023-9.

31. Zawawi KH. Comparison of Wits appraisal among different ethnic groups. J Orthod Sci. 2012; 1(4):88-91.

32. Singh G, Verma S, Singh DP, Yadav SK, Yadav AB. Correlation of beta angle with antero-posterior dysplasia indicators and FMA: an institution based cephalometric study. J Clin Diagn Res. 2016; 10(11):ZC75-8.

33. Shamlan MA, Aldrees AM. Hard and soft tissue correlations in facial profiles: a canonical correlation study. Clin Cosmet Investig Dent. 2015; 12(7):9-15.

34. Jajoo A, Agarkar SS, Sharma S, Gadhiya N, Sonawane S, Narkhede S. Comparison of beta and ANB angles for evaluation of sagittal skeletal discrepancy: a cephalometric study. J Contemp Dent Pract. 2018; 19(6):739□42.