Available online at https://www.mmpubl.com/

International Journal of Orthodontic Rehabilitation

Original Research

Correlation Of ANB Angle, Wit's Appraisal, Beta Angle, Yen Angle And W-Angle In Patients With Class I Skeletal Pattern In Different Growth Patterns

Ajins C.B[1], A. Jebilla Pringle[2], S.D.Milling Tania[3], S. Veerasankar[4], Mary Sheloni Missier[2], I. Bevin Shaga[4]

[1]Post Graduate, [2]Senior Lecturer, [3] Professor and Head of Department, [4]Reader, Department of Orthodontics, Rajas Dental College and Hospital, Kavalkinaru.

How to cite this article: Ajins C.B, A. Jebilla Pringle, S.D.Milling Tania, S. Veerasankar, Mary Sheloni Missier, I. Bevin Shaga. Correlation Of ANB Angle, Wit's Appraisal, Beta Angle, Yen Angle And W-Angle In Patients With Class I Skeletal Pattern In Different Growth Patterns. *Int J Orthod Rehabil 2024; 15 (2) 26-36. Doi: 10.56501/intjorthodrehabil.v15i2.1064.*

Received: 16-05-2024 *Accepted: 17-06-2024* *Web Published: 06-07-2024*

ABSTRACT

Background: Sagittal jaw discrepancies are a critical determinant in orthodontic diagnosis and treatment planning, necessitating an accurate assessment. This study aims to investigate the predictive efficacy of various sagittal parameters (ANB angle, Wits appraisal, Beta angle, Yen angle, and W angle) in diagnosing skeletal Class I malocclusion across diverse growth patterns.

Materials and Methods: A retrospective cross-sectional analysis was conducted using lateral cephalograms of 60 patients diagnosed with skeletal Class I malocclusion. Sagittal skeletal parameters (ANB angle, Beta angle, Yen angle, W angle, and Wits appraisal) were evaluated across three distinct growth patterns (vertical, horizontal, and average). Mean and standard deviation were calculated for each parameter within each growth pattern. One-way ANOVA with post-hoc Tukey's HSD test was employed for pairwise comparisons between groups. The inter-relationship between cephalometric parameters and growth patterns was assessed using Pearson's correlation coefficient, with statistical significance set at $p \leq 0.05$.

Results: A total of 60 participants (30 males and 30 females) with a mean age of 18.60 ± 4.17 years were included in the study. Highly statistically significant differences were noted for Beta and Yen angle ($p \leq 0.001$), whereas statistically significant differences were noted for ANB angle. The correlation test revealed a possible association between assessed parameters in the overall sample.

Conclusion: Angular and linear parameters revealed some degree of correlation in skeletal class I malocclusion patients irrespective of their growth pattern. However, the reliability of individual parameters in accurately classifying the skeletal discrepancies among different malocclusion states should be further investigated.

Keywords: Diagnosis, Skeletal malocclusion groups, Cephalometry, Sagittal parameters, Correlation.

Address for Correspondence:

Dr Ajins C.B.
Postgraduate Student, Department of Orthodontics,
Rajas Dental College and Hospital, Kavalkinaru
Email: drajinscb@gmail.com
Phone No: +91 8940046008

INTRODUCTION

Orthodontic treatment focuses on the precise assessment and correction of dentofacial discrepancies, particularly those involving the maxillomandibular relationship. Accurate evaluation is fundamental to both diagnosis and treatment planning. Deviations from craniofacial skeletal harmony manifested as malocclusion in the sagittal, transverse, or vertical planes, can arise from variations in developmental trajectories.[1] Among these, sagittal discrepancies significantly impact facial aesthetics, function, and patient psychosocial well-being.[2] Recognizing this, the anteroposterior relationship between the maxilla and mandible has long been considered a fundamental criterion for diagnosis, even predating Edward H. Angle's malocclusion classification system introduced in the early 1900s.[3]

Since its inception in 1926 by Broadbent, the lateral cephalometric radiograph has become an indispensable tool in orthodontics for diagnosis, clinical decision-making, and research.[4–5] By clinical orthodontic guidelines, lateral cephalometric radiographs play a crucial role in evaluating skeletal discrepancies, assessing growth patterns, and strategizing for orthodontic-orthognathic surgery, as well as in locating and evaluating unerupted, malformed, or ectopic teeth.[6] Orthodontists use this information to perform various linear and angular cephalometric analyses, facilitating the diagnosis of sagittal discrepancies and the formulation of evidence-based treatment plans.

In 1948, Downs conducted the initial cephalometric analysis, which assessed the sagittal apical base relationship by quantifying the angle of convexity formed by points A, B, Nasion, and Pogonion.[7] Subsequently, Steiner's modification of Riedel's ANB angle gained widespread acceptance as a key metric for anteroposterior jaw relations.[8–9] However, the sensitivity of these angular measurements to vertical growth patterns, positional shifts of Nasion or Sella turcica, and other factors necessitated the exploration of alternative methods.

Jacobson introduced the Wits appraisal as an alternative to the ANB angle for assessing sagittal jaw relationships. This appraisal used the occlusal plane as a reference. However, the robustness of the Wits appraisal was limited by the inherent variability of the occlusal plane and its challenges in determining its functional orientation.[10] Addressing these limitations, Baik and Ververidou proposed a Beta angle solely based on three skeletal landmarks (points A, B, and the apparent condylar axis). This eliminates dependence on cranial or dental references, potentially enhancing the reliability and specificity of anteroposterior skeletal discrepancy evaluation.[11]

While the beta angle assesses sagittal discrepancies, its determination relies on variables A, B, and the mandibular condyle, which may not be distinctly visible. To address this, Neela P.K. and Mascarenhas R. proposed the Yen angle, which uses three readily identifiable reference points: S (midpoint of Sella turcica), M (midpoint of premaxilla), and G (centre of mandibular symphysis).[12] Notably, similar to the ANB angle, the Yen angle can be influenced by jaw rotation secondary to growth or orthodontic treatment, potentially mimicking basal skeletal discrepancies.

Recognizing the limitations of existing methods, Bhad et al [13] proposed the W angle, a novel cephalometric measurement for quantifying maxillomandibular discrepancies. This angle incorporates landmarks identical to the Yen angle (S, M, G) coupled with an angle formed by a perpendicular line extending from point M to the S-G and M-G lines. This approach, independent of unstable landmarks and dental occlusion, offers valuable insights into sagittal plane changes resulting from growth and orthodontic treatment. This method is independent of unstable landmarks or dental occlusion, rendering it valuable for evaluating sagittal plane changes induced by growth or orthodontic treatment.[13]

Assessment of sagittal jaw discrepancies using established cephalometric parameters relies on either cranial reference planes or dental occlusion. However, individual growth patterns exhibit considerable variability, necessitating the generation of growth pattern-specific data and comparison with existing normative values. Therefore, this study aims to use various cephalometric parameters, including the Yen angle, W angle, Beta angle, Wits appraisal, and ANB angle, to predict sagittal jaw dysplasia within the context of different craniofacial growth patterns.

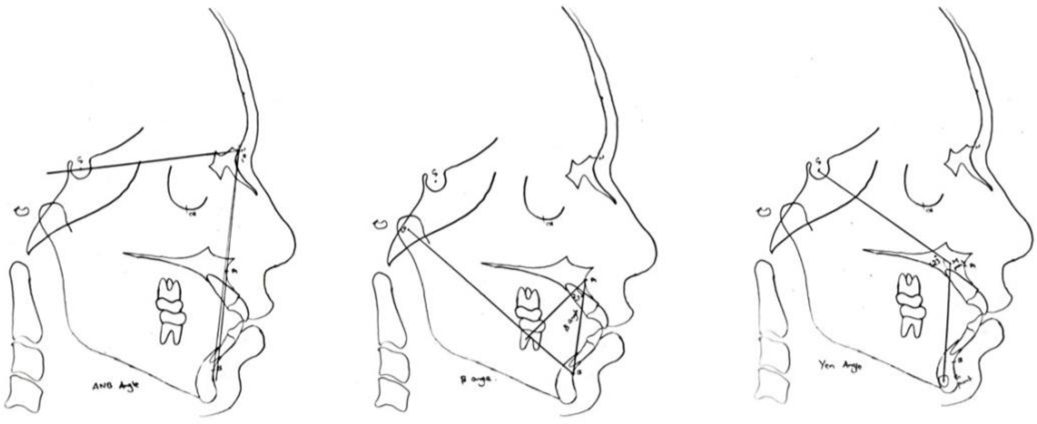
MATERIALS AND METHODS

Study design and setting: A retrospective observational study was conducted on individuals aged 18-25 years presenting for orthodontic treatment at the Department of Orthodontics and Dentofacial Orthopaedics, Rajas Dental College and Hospital. The study adhered to the Declaration of Helsinki, Finland. Written informed consent was obtained from all participants at the time of radiographic exposure. Ethical approval was granted by the Institutional Review Board under reference number RDCH/IRB/EC/05/23.

Participants: A total of 60 high-quality pre-treatment cephalograms of patients (30 males and 30 females), taken over 6 months from May 2023 till November 2023 that met inclusion criteria were included in this study. Patients who had no history of previous orthodontic treatment with no craniofacial malformation or facial disfigurement and with no missing teeth in permanent dentition were selected. Any patients with a history of trauma, TMJ abnormalities, and medically compromised states were excluded from this study. All participants underwent clinical examinations before cephalometric radiographs. Subsequently, patients exhibiting Class I Angle malocclusion based on combined clinical and radiographic analyses were included in the study.

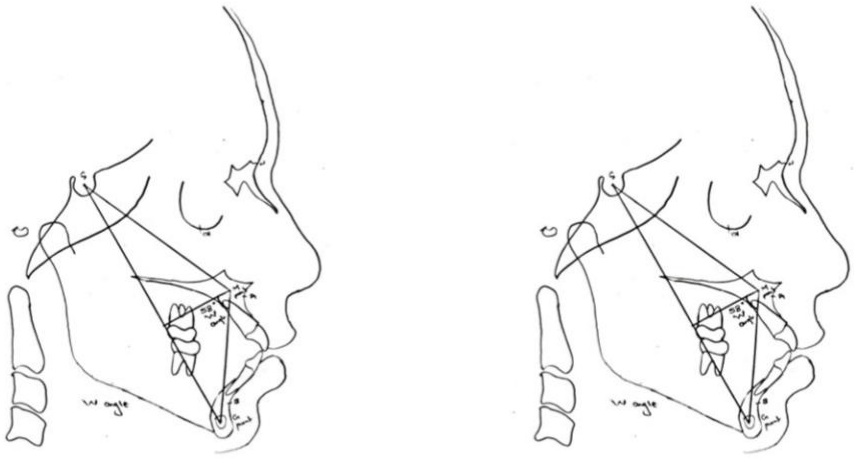
Source of data: Lateral cephalograms were acquired adhering to a standardized protocol. The Frankfurt horizontal plane was aligned parallel to the floor, and the midsagittal plane was positioned perpendicular to the X-ray beam. The patient maintained a natural head position stabilized by the cephalostat during image capture. Centric occlusion with passive lip engagement was ensured for optimal lateral cephalometric radiographs.Imaging was performed using an ORTHOPHOS XG Sirona dental system (Germany) at a maximum potential of 80 kV and a total filtration of 2.5 mm aluminium. Following the acquisition, the radiograph was calibrated and printed on hard copy using a DRYPIX Lite printer (Fujifilm Corporation).Cephalometric tracings were subsequently executed by a single observer. An X-ray viewer box facilitated tracing using a 0.3 mm hard black lead pencil on a 0.003-inch-thick transparent cellulose acetate sheet.

Parameters assessed: Initially landmarks in the lateral cephalogram required for analysis were marked that were classified as points and lines based on the skeletal, dental, and soft tissue landmarks defined by Alexander Jacobson et al [14] and Thomas Rakosi et al[15] (Figs 1 & 2). Points A, B, and C stand for Subspinale, Supramentale, and apparent axis of the mandibular condyle, respectively; Points M, N, and S stand for the midpoint of the premaxilla, Nasion, and the midpoint of Sella turcica, respectively; Line connecting point N with A and B is the N-A and N-B line, respectively; Line connecting point B with C and A is the B-C and B-A line, respectively; Line connecting point M with S and G is the S-M and M-G lines, respectively; All measured parameters are described in Table 1. A sample of 20 radiographs was assessed again by the same observer who performed an initial analysis after 1 month to assess the intra-observer reliability.



a b c

Figure 1: Depiction of the measured parameter. a) ANB angle; b) Beta angle; c) Yen angle



a b

Figure 2: Depiction of the measured parameter. a) W angle; b) Wits appraisal

Parameter	Description
ANB Angle	The angle formed by lines connecting the points A, B and N (Figure 1a)
Beta Angle	The angle formed by lines B-C, B-A lines and a line perpendicular to the B-C line (Figure 1b)
Yen Angle	The angle formed by lines S-M and M-G (Figure 1c)
W Angle	The angle formed by a perpendicular line from Point M to the S-G line and the M-G line (Figure 2a)
Wit's Appraisal	The linear distance between points A and B perpendicular to the functional occlusal plane (Figure 2b)

Table 1: Parameters assessed along with its description.

Sample size estimation: Sample size estimation was performed using G*Power software based on parameters from a previous study[16]. An α level of 0.05 and a power of 80% were set within a 95% confidence interval. The minimum required sample size per growth pattern (horizontal, vertical, and average) was estimated to be 20 individuals. Therefore, a total sample size of 60 individuals was determined, considering three distinct growth patterns.

Statistical analysis: Anteroposterior skeletal angle measurements were recorded and analysed according to growth patterns. Descriptive statistics (means and standard deviations) were calculated for ANB, Beta, W, Yen, and Wits appraisal angles. Statistical Package for Social Sciences (SPSS) for Windows (Version 23.0, SPSS Inc. Chicago). One-way ANOVA compared ANB, Wits, Beta, Yen, and W angles across horizontal, average, and vertical class I malocclusion patterns, followed by post-hoc Tukey HSD tests for pairwise comparisons. Pearson's correlation coefficients (r) and multiple linear regression assessed the relationships between all five sagittal jaw markers in the entire sample. Intra-observer reliability was evaluated using Cohen's kappa statistics. Statistical significance was set at $p < 0.05$.

RESULTS

Lateral cephalometric analysis was performed on 60 patients (26 males, 34 females) diagnosed with skeletal class I malocclusion (mean age 18.60 ± 4.17 years). The patients were further categorized into three groups (n=20 each) based on their skeletal growth patterns (horizontal, average, vertical) as determined by the cephalometric analysis. Descriptive statistics for the ANB angle, Wits appraisal, Yen angle, W angle, and Beta angle are presented in Table 2, categorized by growth pattern.

Sagittal Jaw relationship measures	**n**	**Mean ± SD**	**Minimum**	**Maximum**
ANB Angle (^{0})	60	2.73 ± 1.23	.00	4.00
Wits Appraisal (mm)	60	0.20 ± 2.00	-5.00	7.00
Beta Angle (^{0})	60	32.86 ± 4.11	22.00	39.00
Yen Angle (^{0})	60	118.85 ± 4.62	108.00	134.00
W Angle (^{0})	60	53.35 ± 2.97	45.00	61.00

Table 2: Descriptive statistics of the Sagittal jaw relationship measures in various patterns of Class I Malocclusion. All values are expressed as mean ± standard deviation (SD). º denotes angle and mm denotes measurement in millimetres.

The present study investigated intergroup differences in ANB angle, Wits appraisal, Beta angle, Yen angle, and W angle among horizontal, average, and vertical skeletal patterns within Class I malocclusion. Statistically significant variations were observed for the ANB angle (p = 0.007), with highly significant differences for the Beta angle and Yen angle (p = 0.001 and 0.000, respectively). Post hoc Tukey test revealed significant differences in ANB, Beta, and Yen angles between both vertical and horizontal skeletal patterns compared to the average pattern. Detailed intergroup comparisons for all assessed parameters across skeletal growth patterns are presented in Table 3, including mean values, standard deviations, upper and lower bounds of the 95% confidence intervals.

Sagittal Jaw relationship measures		n	Mean ± SD	95% Confidence Interval for Mean		p-value
				Lower Bound	Upper Bound	
ANB Angle (^{0})	Horizontal	20	2.10 ± 1.44^γ	1.42	2.77	0.007*
	Average	20	2.80 ± 1.10	2.28	3.32	
	Vertical	20	3.30 ± 0.80^α	2.92	3.68	
Wits Appraisal (mm)	Horizontal	20	0.10 ± 2.24	-.95	1.15	0.443
	Average	20	0.65 ± 1.49	-.050	1.35	
	Vertical	20	-0.15 ± 2.20	-1.18	.88	
Beta Angle (^{0})	Horizontal	20	31.00 ± 4.00^γ	29.13	32.87	0.001**
	Average	20	32.15 ± 3.80^γ	30.37	33.93	
	Vertical	20	35.45 ± 3.28^{αβ}	33.91	36.99	
Yen Angle (^{0})	Horizontal	20	121.70 ± 4.60^γ	119.55	123.85	0.000**
	Average	20	118.80 ± 4.43	116.73	120.87	
	Vertical	20	116.05 ± 2.94^α	114.67	117.43	
W Angle (^{0})	Horizontal	20	53.80 ± 3.81	52.01	55.59	0.341
	Average	20	53.70 ± 2.90	52.34	55.06	
	Vertical	20	52.55 ± 1.84	51.68	53.42	

Table 3: Intergroup comparisons of ANB angle, Wits appraisal, Beta angle, Yen angle and W angle between various patterns of class I malocclusion (horizontal, average and vertical). All values are expressed as mean ± standard deviation (SD). The statistical tests used: One-way ANOVA with Tukey post-hoc test. Level of significance: * $p \leq 0.05$ is considered statistically significant. ** $p \leq 0.001$ is considered highly statistically significant. Groups with different Greek letters in superscript show statistically significant differences (α - Horizontal, β - Average, γ - Vertical).

Correlations between skeletal parameters and growth patterns are detailed in Table 4. Key findings include:

1. Moderately weak negative correlation between ANB angle and Yen as well as W angle ($p \leq 0.001$).
2. Weak correlation between Wits appraisal and Beta angle ($p \leq 0.05$).
3. Strong positive correlation between Yen and W angles ($p \leq 0.001$).

Sagittal jaw relationship measures		ANB Angle	Wits Appraisal	Beta Angle	Yen Angle	W Angle
ANB Angle	Pearson Correlation	1	.07	-.05	-.43**	-.44**
	Sig. (2-tailed)	-	.60	.70	.00	.00
Wits Appraisal	Pearson Correlation	-	1	-.26*	-.14	-.19
	Sig. (2-tailed)	-	-	.05	.30	.15
Beta Angle	Pearson Correlation	-	-	1	-.01	.23
	Sig. (2-tailed)	-	-	-	.95	.07
Yen Angle	Pearson Correlation	-	-	-	1	.76**
	Sig. (2-tailed)	-	-	-	-	.00
W Angle	Pearson Correlation	-	-	-	-	1
	Sig. (2-tailed)	-	-	-	-	-

Table 4: Correlation between skeletal parameters and skeletal growth patterns. The statistical test used was: the Pearson correlation test. * indicates statistical significance at $p \leq 0.05$. ** indicates statistical significance at $p \leq 0.001$.

DISCUSSION

Orthodontic treatment planning depends on a comprehensive understanding of skeletal and soft tissue contributions to the facial profile. While factors such as nose size, lip posture, and chin morphology influence soft tissue expression, the underlying sagittal relationship between the apical base and the jaws serves as the primary determinant of anteroposterior jaw discrepancy.[17-18] Accurate assessment of these skeletal discrepancies is crucial for establishing a successful treatment plan that optimizes both dental and facial aesthetics.

Cephalometric radiograph has been an indispensable tool in orthodontic diagnosis since its inception in 1932 by Broadbent [4]. Later, Wylie introduced the method of assessing the maxillary and mandibular jaws in the sagittal plane using angular and linear measurements. [17] Variability in angular measurement results due to changes in inclination and prognathism of the jaw as well as changes in height of the face, whereas linear measurement is influenced by the inclination of the reference line. Hence, the assessment of skeletal patterns to incorporate them in treatment planning is essential for identifying discrepancies. [8]

In the present study, skeletal discrepancy was assessed using five different parameters (ANB angle, Wits appraisal, Beta angle, Yen angle, and W angle) in three different growth patterns of patients having skeletal class I malocclusion. ANB angle, a skeletal parameter is the widely used parameter to assess sagittal skeletal discrepancies [11]. It was noted that the ANB angle was affected by growth in the vertical direction and nasion movement following growth [19-20]. The overall mean ANB angle noted in this study was2.73 ± 1.23º, which was in concordance with values reported by Kumar et al.,[3] and Mittal et al.,[21] of 2.78±0.83º and 2.79±0.98º, respectively. Contrary to this, increased mean values were reported by Soni et al [22] and Kapadia et al [16]in their studies.

Wits appraisal introduced as an alternative by Jacobson, overcomes the pitfalls of the ANB angle. Measurement lies in the accurate identification of the occlusal plane and change in the angulation of the functional plane influences Wits appraisal. In this present study, the mean value of Wits appraisal was 0.20 ± 2.00 mm with a negative value noted in the vertical growth pattern (-0.15 ± 2.20 mm). These values were similar to the mean values presented in previous studies in the range from -0.42 to 0.43. [3, 21, 23-24]

Beta angle introduced by Baik et al [11] is a measurement that is least affected by changes in the cranial base and rotation of the jaw. The mean value for the Beta angle was 32.86±4.11º in the present study with similar values for horizontal and average growth patterns, whereas an increased value of approximately3º was noted in the vertical growth pattern. Similar values reported in the previous studies ranged from 30.11º to 34.67º [3, 21, 23, 25-26].

Neela et al [12] introduced the Yen angle, named after Yenepoya Dental College, as a skeletal dysplasia indicator with minimal growth-related changes and applicability in mixed dentition. The present study found a mean Yen angle of 118.85 ± 4.62°, consistent with previously reported values in the Indian population [3, 16, 21-22, 24, 26, 27]. Bhad et al [13] proposed the W angle, which is minimally affected by jaw rotation and vertical facial growth. It can be used to assess treatment progress. The W angle exhibited a mean value of 53.87 ± 1.35°, which is nearly identical to the values reported by previous researchers. [3, 16, 21-22, 24, 26]

Sagittal skeletal parameter correlations were examined using Pearson's correlation test. A weak negative correlation was observed between the Yen angle and both the Wits appraisal and Beta angle. Conversely, Kumari et al [3], Mittal et al [21], and Bohra et al [26] reported a strong positive correlation between the Yen angle and W angle. Additionally, a strong positive correlation was found between the ANB angle and the Wits appraisal, consistent with the findings of Ahmed et al [23] and Kapadia et al [16]. However, Mittal et al [21] reported a negative correlation for this relationship.

Limitations of the present study include that the present study is focused on Class I skeletal malocclusion with diverse growth patterns. This restriction prohibits a thorough evaluation of sagittal skeletal discrepancies and their potential associations with the investigated parameters. Furthermore, the limited sample size restricts the generalizability of the findings. Future studies should incorporate a larger and more diverse sample encompassing various ethnicities, acknowledging the known inter-population and racial variations. Additionally, incorporating a broader range of skeletal parameters could enhance diagnostic accuracy and treatment plan customization for individual subjects.

CONCLUSION

This present study observed a degree of correlation between angular and linear parameters in skeletal Class I malocclusion with varying growth patterns. Comparing Indian population-specific studies, the ANB angle exhibited minimal variability compared to other parameters employed to assess sagittal jaw discrepancy, while demonstrating comparable diagnostic accuracyin this study. However, further research is warranted to assess the reliability of each parameter in diagnosing anteroposterior jaw discrepancies across diverse skeletal malocclusions.

COMPETING INTERESTS

The authors declare that they have no competing interests in this study.

SOURCE OF FUNDING

This research received no external funding.

REFERENCES

1. Proffit WR, Fields HW, Sarver DM. *Contemporary Orthodontics*. 5th ed. St. Louis: Mosby Elsevier, 2007.
2. Azuma S, Kohzuki M, Saeki S, Tajima M, Igarashi K, Sugaware J. Beneficial effects of orthodontic treatment on quality of life in patients with malocclusion. *Tohoku J Exp Med*. 2008 Jan;214(1):39-50.
3. Kumari P, Jain AK, Sahu A, Prasad RR, Singh S, Roy S. Predictability of Wits appraisal, ANB, Beta, Yen, W, µ and Pi angle as indicators of anteroposterior dysplasia in Jharkhand population. *J Contemp Orthod*. 2023;7(2):79-89.
4. Broadbent B Sr, Broadbent B Jr, Golden W. *Bolton Standards Of Dentofacial Development Growth*. St Louis: Mosby; 1975.
5. Graber TM, Vanarsdall R. *Orthodontics: Current Principles And Techniques*. 4th ed. St. Louis: Mosby; 1994. p. 928.
6. Isaacson K, Thom A, Horner K, Whaites E. Guidelines for the use of radiographs in clinical orthodontics. London, United Kingdom: *British Orthodontic Society*; 2008.
7. Downs WB. Variations in facial relationships; their significance in treatment and prognosis. *Am J Orthod* 1948;34(10):812-840.
8. Riedel R. The relation of maxillary structures to cranium in malocclusion and in normal occlusion. *Angle Orthod* 1952; 22:142-145.
9. Steiner CC. Cephalometrics for you and me. *Am J Orthod* 1953;39(10):729-755.
10. Jacobson A. The Wits appraisal of jaw disharmony. *Am J Orthod*. 1975 Feb;67(2):125-38.
11. Baik CY, Ververidou M. A new approach of assessing sagittal discrepancies: the Beta angle. *Am J Orthod Dentofacial Orthop*. 2004 July;126(1):100-5.
12. Neela PK, Mascarenhas R, Husain A. A new sagittal dysplasia indicator: The YEN angle. *World J Orthod* 2009;10:147-51.
13. Bhad WA, Nayak S, Doshi UH. A new approach to assessing sagittal dysplasia: The W angle. *Eur J Orthod* 2013;35:66-70.
14. Jacobson A. Radiographic cephalometry from basics to video imaging. and others, editor. *Quintessence publishing Co*, Inc; 1995. p. 322.
15. Rakosi T. *An atlas and manual of cephalometric radiography*. 1982 Oct.

16. Kapadia RM, Diyora SD, Shah RB, Modi BN. Comparative evaluation of YEN angle and W Angle with ANB Angle, Wits Appraisal, and Beta Angle for predicting sagittal jaw dysplasia: a cephalometric study. *Int J Clin Dent Res*. 2017 Jan;1(1):26-31.
17. Wylie W. The assessment of anteroposterior dysplasia. *Angle Orthod*. 1947;7:97–109.
18. Fida M. A comparison of cephalometric analyses for assessing sagittal jaw relationship. *J Coll Physician Surg Pak*. 2008;18(11):679–83.
19. Brown, M., 1981. Eight methods of analysing a cephalogram to establish anteroposterior skeletal discrepancy. *J Orthod*. 8 (3), 139–146.
20. Chang, H.P., 1987. Assessment of anteroposterior jaw relationship. *Am J Orthod Dentofacial Orthop*. 92 (2), 117–122.
21. Mittal A, Bohra S, Murali PS, Saidath K, Krishna Nayak US. An evaluation of YEN and W angle in the assessment of anteroposterior jaw relationship. *J Indian Orthod Soc*. 2016 Jan; 50(1):26-30.
22. Datar S, Soni G, Goel S, Gupta N, Kotecha T, Yadav N. Comparative Evaluation of Yen Angle and W Angle with ANB Angle and Wits Appraisal for Predicting Sagittal Jaw Dysplasia. *Eur J Molecular & Clin Med*. 2021 Feb 19;8(2):2234-42.
23. Ahmed M, Shaikh A, Fida M. Diagnostic validity of different cephalometric analyses for assessment of the sagittal skeletal pattern. *Dental Press J Orthod*. 2018 Sep;23:75-81.
24. Gupta AK, Kumar A, Ashraf K, Hussain K, Kumar A, Kulshrestha R. Establishment of cephalometric norms of Yen, W and Beta angle with assessment of sagittal jaw relationship in Eastern Indian population. *Indian J Orthod Dentofacial Res*. 2019 Apr;5(2):63-.
25. Qamaruddin I, Alam MK, Shahid F, Tanveer S, Umer M, Amin E. Comparison of popular sagittal cephalometric analyses for validity and reliability. *Saudi Dent J*. 2018 Jan 1;30(1):43-6.
26. Bohra S, Udeshi PS, Sinha SP, Saidath K, Shetty KP, Nayak UK. Predictability of PI angle and comparison with ANB angle, W angle, Yen angle, and Beta angle in South Indian Population. *J Indian Orthod Soc*. 2018 Jan 1;52(1):22-8.
27. Wani KM, Manerikar R, Jethe S, Deshmukh S, Rahalkar J. Mean values of Beta Angle and YEN Angle in Maratha ethnic population and their reliability on select local population: A cephalometric observational study. *Int J Oral Health Dentis*. 2017;3(1):43-9.

Published by MM Publishers

https://www.mmpubl.com/ijorthrehab