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Research Article

Reliability of Numeric Measurements for Measuring Sagittal Discrepancies

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Abstract:
Background: Cephalometrics is an established diagnostic and research tool in orthodontic practice. Its primary role has been the evaluation of facial form using angular and linear measurements. Numeric Parameters are used to evaluate the sagittal discrepancies.
Aim and objectives: To evaluate and compare the reliability of different numeric cephalometric parameters in assessing the sagittal jaw discrepancies in Konaseema population.
Methodology: Sample size of the study is convenience sample of 90 and the sample was selected based on their malocclusions. Each malocclusion is divided into a group of 30 and a total of 3 groups were selected according to the sample size. Pretreatment lateral cephalograms of patients with sagittal discrepancies is taken. Convenience sample of 90 is taken & the patients who are about to start orthodontic treatment will be taken into consideration. All Lateral Cephalograms are taken with Standard Cephalometric Machine (Kodak Carestream CS8100) and Printer (Kodak Carestream Dry view 5700 Laser imager) with Magnification at 100.
Results: Statistically significant difference was observed when the comparison done between the numeric parameters. Multiple pairwise comparisons of parametric measures between the study groups have shown that Significant differences were noted between the study groups in relation to all the four parametric measures. While highest “mean values” for “Yen angle” and “Tau angle” were observed in Group II, Group III had highest HBN and W angle mean values.
Conclusions: Cephalometric measures, which are group-based norms. comparison with numeric measurements like YEN, TAU, HBN and W angles. The Yen angle, Tau angle is accurate and reliable in comparison with other numeric parameters.

Key words: YEN, TAU, HBN, W angles, Parametric

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Introduction:

Orthodontics is a specialized field of dentistry that focuses on diagnosing, preventing, and correcting malocclusions (abnormalities in the alignment of the teeth and jaws). To achieve successful orthodontic treatment, orthodontists employ various diagnostic tools and techniques, one of which is cephalometrics. Cephalometrics is a vital aspect of orthodontics, providing valuable insights into the craniofacial structures of patients. In this introduction, we will explore the key concepts and applications of cephalometrics in orthodontics[1].

Cephalometrics was first discovered in 1931, and since then, it has been developed into a crucial clinical technique for evaluating the relationship between the jaws in all three planes (vertical, transverse, and anterior), which is an essential aspect of orthodontic treatment planning. The patient's major worry is typically the sagittal connection, which requires a thorough evaluation[1].

There are apparent issues with both angular and linear measurements, which have been thoroughly addressed in the literature. Cranial reference planes such as the Frankfort horizontal and the Sella-Nasion line have been utilized to identify jaw dysplasia. Furthermore, extracranial measures that are independent of cranial reference planes and dental occlusion that perfectly captures the sagittal relationship have found use.

Lateral cephalograms are frequently used to assess sagittal jaw discrepancy. Many methods are used to assess the sagittal discrepancies. ANB angle, WITS appraisal, Beta angle are some of the commonly used parameters. ANB angle was introduced by Riedel and it has gain popularity since its introduction. But some factors affect the reliability of ANB angle. During cephalogram projection the sidewards or upward rotation of the head affects the ANB reading. Variance in the length of the cranial base also affect the ANB angle. To overcome these problems Wits appraisal was introduced by Jacobson.

Wit's appraisal also has some limitations that occlusal plane is used as reference plane. Which is a dental parameter and it can be affected by orthodontic tooth movement. So, ANB and Wits appraisal are used conjunctively. To overcome these difficulties Beta angle was introduced but it also uses point A as the landmarks like other previous angles to determine sagittal discrepancies.[1]

To overcome these difficulties W angle, YEN angle, HBN angle and TAU angle are introduced. However, the validity and reliability of these newer parameters is not yet ascertained[2].

AIM

To evaluate and compare the reliability of different numeric cephalometric parameters in assessing the sagittal jaw discrepancies in konaseema population

OBJECTIVES OF THE STUDY

evaluating the reliability of numeric cephalometric parameters in konaseema population i.e.

1. To evaluate the reliability of W angle in different malocclusions
2. To evaluate the reliability of Tau angle in different malocclusions
3. To evaluate the reliability of HBN angle in different malocclusions
4. To evaluate the reliability of YEN angle in different malocclusions

Material and Methods

The Present study was done to evaluate the reliability of numeric measurements for sagittal discrepancies from Konaseema region. Individuals who reported to the **Department of Orthodontics and Dentofacial Orthopaedics, KIMS Dental College, Amalapuram**, were selected for the study. The age group selected for this study was 18 – 24 years.

Sample Selection

Sample size of the study is convenience sample of 90 and the sample was selected based on their malocclusions. Each malocclusion is divided into a group of 30 and a total of 3 groups were selected according to the sample size.

Pretreatment lateral cephalograms of patients with sagittal discrepancies is taken. Convenience sample of 90 is taken & the patients who are about to start orthodontic treatment is taken into consideration.

After taking proper history to determine the ethnicity. The participants were explained about the study and those who consented of taking lateral cephalograms were included in the study. An 90 patients with equal number of Class I, II, III who met the inclusion criteria.

All Lateral Cephalograms are taken with Standard Cephalometric Machine (Kodak Carestream CS8100) and Printer (Kodak Carestream Dry view 5700 Laser imager) with Magnification at 100.

Inclusion criteria:

1. Individuals from Konaseema region
2. Age of the subjects **18 to 24** years.
3. For Group I the molar relation should be in Angles Class I relation
4. For Group II the molar relation should be in Angles Class II relation
5. For Group III the molar relation should be in Angles Class III relation

Complete set of dentitions including 2nd molars were selected

Exclusion Criteria

1. No craniofacial anomalies
2. No history of systemic diseases.
3. No congenital anomalies.

Measurements on the lateral cephalometric radiographs

Lateral Cephalometric radiograph of each subject was taken with a standardized approach to obtain the radiograph in the **natural head position** with the teeth in the occlusion.

All the Cephalograms are traced and each Traced cephalogram is Scanned and Xeroxed with 1:1 magnification. Each traced Cephalogram is taken 5 Prints and analysis is done on them.

Study Groups

Each study group is divided into 3 groups. Each containing 30 subjects with same malocclusions. Ethical committee approval is done for this study.

Analysis on Lateral Cephalogram for Numeric Measurements

• YEN angle
• W angle
• HBN angle
• TAU angle

YEN angle[16]

The YEN angle got its name since it was created in the Orthodontics and Dentofacial Orthopedics Department at **YENEPOYA Dental College in Mangalore,Karnataka, India**. It makes use of S, the midpoint of the sella turcica; M, the midpoint of the premaxilla; and G, the centre of the greatest circle tangent to the internal inferior, anterior, and posterior surfaces of the mandibular symphysis, as its three reference points. When S, M, and G are connected, they form the YEN angle, which is measured at M.

YEN angle between 117 degrees and 123 degrees can be considered a skeletal Class I, YEN angle less than 117 degrees as a skeletal Class II, and a YEN angle greater than 123 degrees as a skeletal Class III.

W angle[18]

A novel metric for evaluating the skeletal disparity in the sagittal plane between the maxilla and mandible is the W angle. It measures an angle that represents the kind and degree of skeletal dysplasia in the sagittal dimension using three skeletal landmarks: point S, point M, and point G.

The first step in determining the W angle is to locate the following three points: Point G is the center of the biggest circle that is tangent to the internal inferior, anterior, and posterior surfaces of the mandibular symphysis. Point S is the midway of the sella turcica; Point M is the midpoint of the premaxilla.

The mean value of w angle in class I malocclusion is 53.67.class II mean value is 46.20. class III malocclusion mean of w angle is 62.80.

HBN angle[17]

This new angle, called the HBN angle (Harsh Bhagvati prasad Nita angle), is especially useful when previously established cephalometric measurements, like the ANB angle and the Wits appraisal, cannot be used accurately due to their dependence on varying factors.

A novel metric for evaluating the sagittal relationship between the maxilla and mandible is the HBN angle. The apparent axis of the condyle, the midpoint of the premaxilla, and the centre of the greatest circle tangent to the internal inferior, anterior, and posterior surfaces of the mandibular symphysis, or "G," were the three skeletal markers that were employed.

"C" denotes the condyle centre, which can be approximated by tracing the condyle's head. "M" denotes the premaxilla midpoint, which can be found by forming the best-fitting circle tangent to the maxilla's superior, anterior, and palatal surfaces and then approximating its centre. "G" denotes the centre of the largest circle that is tangent to the mandibular internal inferior, anterior symphysis.

HBN angle between 39° and 46° indicates a Class I skeletal pattern; an HBN angle <39° indicates a Class II skeletal pattern; and HBN angle >46° indicates a Class III skeletal pattern.

Tau angle[14]

A new measure to ascertain the bone sagittal maxillomandibular connection is the Tau angle. Three cephalometric landmarks are marked to create the Tau angle: Point T: The highest point where the tuberculum sellae and pituitary fossa's frontal walls converge. Point M: Constructed point representing the center of the biggest circle that is tangent to the frontal, upper, and palatal surfaces of the maxilla; Point G: Focal point of the biggest circle that is tangent to the inner frontal, posterior, and lower edge of the mandibular symphysis. Tau angle lies between the two lines connecting T and G points and M and G points.

Tau angles between 28° and 34° approx., <28°, and >34° approx. suggest skeletal class I, III, and II malocclusions.

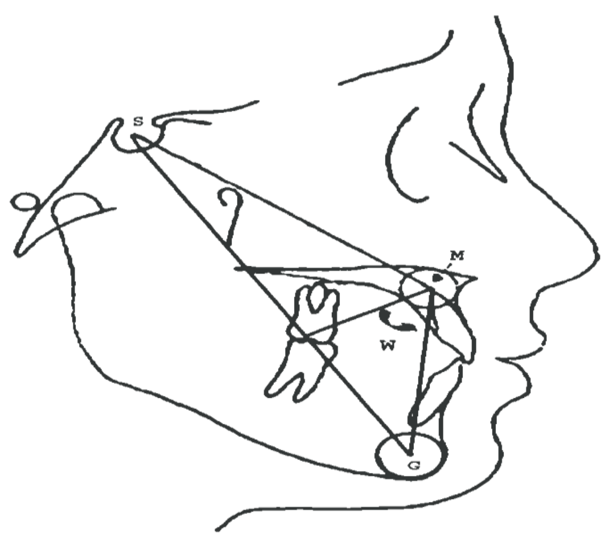

Fig 1. YEN angle Measurements

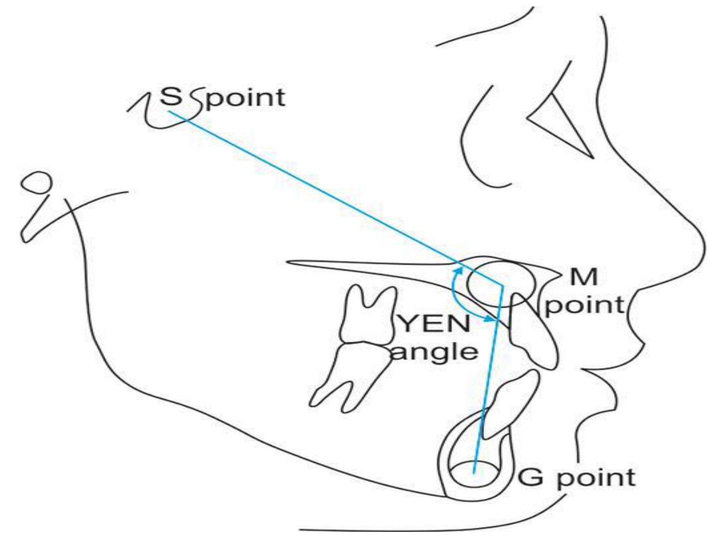

Fig 2.W angle Measurements

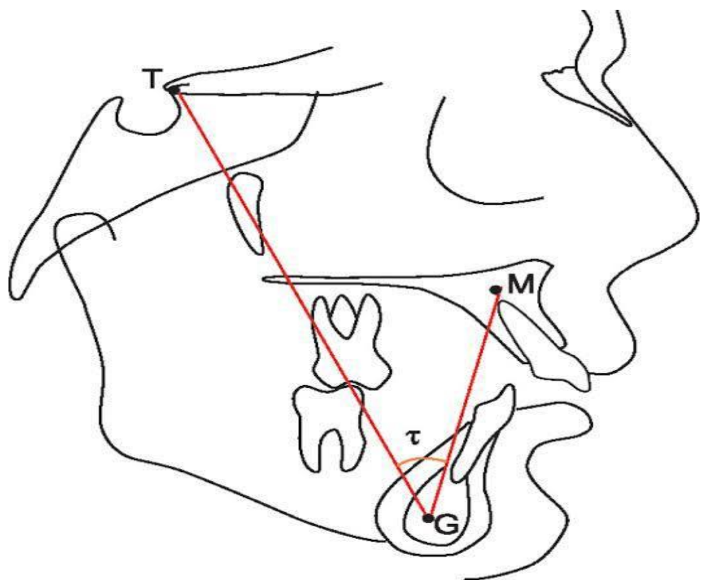

Fig 3 HBN angle Measurements

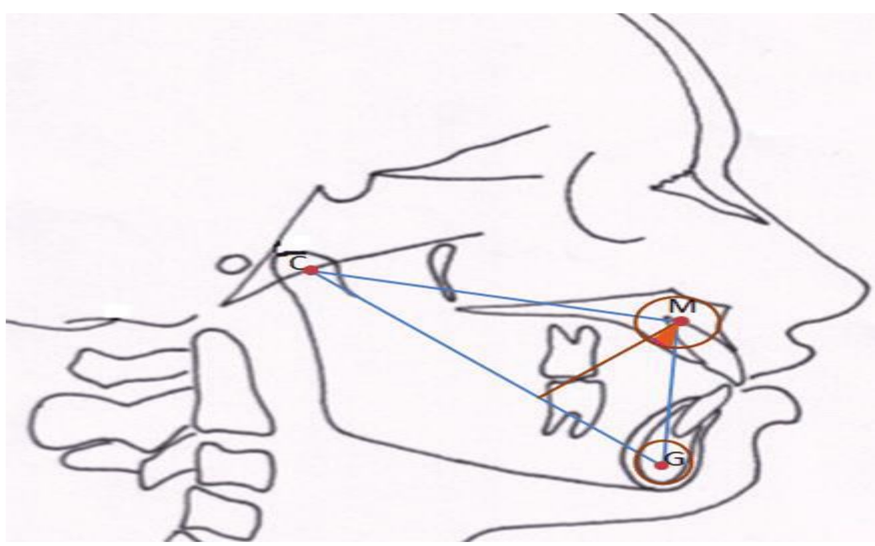

Fig 4.TAU angle Measurements

Statistical analysis:
Data were analyzed using IBM SPSS version 20 software (IBM SPSS, IBM Corp., Armonk, NY, USA). Descriptive statistics, one-way analyses of variance with Tukey's post hoc tests, and chi square tests were done to analyze the study data. Bar charts with positive error bars were used for data presentation.

Results
In orthodontic practice, cephalometrics is a highly regarded diagnostic and research technique. Its primary objective has been to assess the shape of faces by using linear and angular measures.most cephalometric techniques compare the results quantitatively to standards derived from preselected normal people.
But every person exhibits a different pattern of craniofacial development. Therefore, it's possible that these preselected "normal" samples lack morphologic homogeneity.
The sagittal discrepancies are assessed using a variety of techniques. ANB angle, WITS evaluation, and beta angle are a few of the often-utilised variables. Since Riedel introduced the ANB viewpoint, it has grown in popularity. However, a few variables influence how reliable is the ANB angle.

Table 1: Comparison of parametric measures between the study groups

Measure	Group	N	Mean	Std. Deviation	Std. Error Mean	F value	P value
Yen angle	I (ANB 1-3°, Beta angle 27-35°, Class I molar relation)	30	113.37	6.145	1.122	30.7	<0.001*
	II (ANB > 4°, Beta angle < 27°, Class II molar relation)	30	113.77	6.474	1.182		
	III (ANB < 2°, Beta angle > 35°, Class II molar relation)	30	125.70	8.005	1.461		
HBN angle	I (ANB 1-3°, Beta angle 27-35°, Class I molar relation)	30	41.43	5.569	1.017	27.01	<0.001*
	II (ANB > 4°, Beta angle < 27°, Class II molar relation)	30	43.93	4.631	.845		
	III (ANB < 2°, Beta angle > 35°, Class II molar relation)	30	50.27	4.076	.744		
W angle	I (ANB 1-3°, Beta angle 27-35°, Class I molar relation)	30	49.43	4.199	.767	9.63	<0.001*
	II (ANB > 4°, Beta angle < 27°, Class II molar relation)	30	47.17	4.442	.811		
	III (ANB < 2°, Beta angle > 35°, Class II molar relation)	30	51.87	3.776	.689		
Tau angle	I (ANB 1-3°, Beta angle 27-35°, Class I molar relation)	30	37.97	3.882	.709	82.73	<0.001*
	II (ANB > 4°, Beta angle < 27°, Class II molar relation)	30	38.10	3.367	.615		
	III (ANB < 2°, Beta angle > 35°, Class II molar relation)	30	26.77	4.431	.809		

One way analysis of variance; * denotes statistical significance

Figure 5: Comparison of parametric measures between the study groups

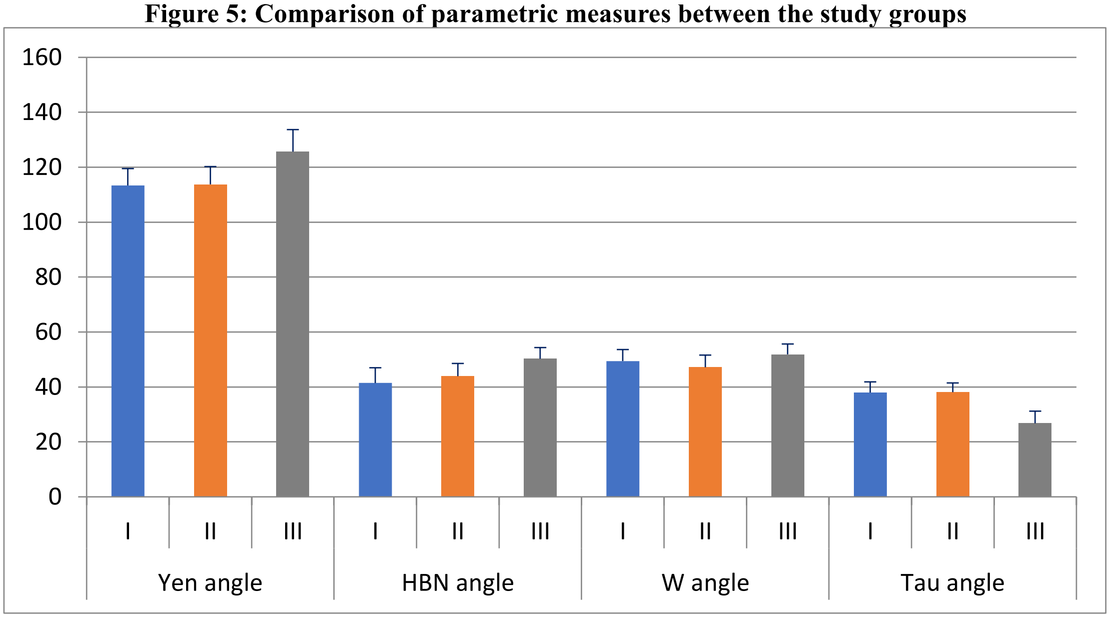

Table 2: Multiple pairwise comparisons of parametric measures between the study groups

Measure	Reference Group	Comparison Group	Mean Difference (I-J)	P value	95% Confidence Interval	
					Lower Bound	Upper Bound
Yen angle	1	2	-.400	.973	-4.66	3.86
		3	-12.333	<.001*	-16.60	-8.07
	2	3	-11.933	<.001*	-16.20	-7.67
HBN angle	1	2	-2.500	.114	-5.45	.45
		3	-8.833	<.001*	-11.79	-5.88
	2	3	-6.333	<.001*	-9.29	-3.38
W angle	1	2	2.267	.092	-.29	4.82
		3	-2.433	.065	-4.99	.12

	2	3	-4.700	<.001*	-7.25	-2.15
Tau angle	1	2	-.133	.990	-2.55	2.28
		3	11.200	<.001*	8.79	13.61
	2	3	11.333	<.001*	8.92	13.75

Tukey's post hoc tests; * denotes significance

W angle, YEN angle, HBN angle, and TAU angle are presented to get around these challenges. But it's still unclear if these more recent parameters are genuine and reliable. Yen angle, Tau angle, W angle and HBN angle are the new parameters which help in evaluating the sagittal discrepancies. These are numeric measurements and the literature about them is limited. So, the present mainly validated on the reliability of these numeric measurements in evaluating the sagittal discrepancies.

Table 1 shows the comparison of parametric measures between the study groups. Significant differences were noted between the study groups in relation to all the four parametric measures. While highest "mean values" for "Yen angle" and "Tau angle" were observed in Group II, Group III had highest HBN and W angle mean values.

In multiple pairwise comparisons as shown in Table 2, there were no "significant differences" in any of the four parametric measures "between Groups I and II"; however, both the groups demonstrated significant difference with Group III, except for the non-significant difference in W angle between Group I and Group III.

Discussion

The quest for precise and comprehensive methods to evaluate sagittal jaw relationships in orthodontics has been a longstanding pursuit. Traditional diagnostic tools, while fundamental, often lack the granularity needed for individualized treatment planning. Hence, this study aimed to bridge this gap by exploring a diverse spectrum of numeric cephalometric measurements and their comparison with non-numeric assessments[1].

By scrutinizing parameters like the W angle, Tau angle, HBN angle, and YEN angle, alongside qualitative evaluations such as centrographic analysis and growth pattern classification, this research sought to establish a more nuanced and holistic approach to diagnosing sagittal jaw discrepancies. This comprehensive assessment was driven by the understanding that a singular metric or assessment might not encapsulate the intricacies of craniofacial relationships.[14]

In the study by Mittal et al., assess sagittal jaw discrepancies using cephalometric measurements like YEN angle and W angle. In our study we incorporated a diverse sample categorized into different malocclusions based on multiple angles and appraisals, aiming for a broader understanding of sagittal jaw relationships across varied criteria. In contrast, Mittal et al.'s study concluded that YEN is the best predictor among YEN and W angle[8].

In Present Study it is concluded that YEN angle is the Reliable numeric measurement among all taken Numeric Parameters. Both the studies concluded that YEN angle is a Reliable numeric measurement that is helpful in evaluating the sagittal malocclusions[16].

Dr. Jamadgni Gor et al[15]. and present study is mainly done to explore the predictability and variability of specific cephalometric measurements in assessing sagittal jaw relationships. Dr. Gor's study mainly made his on study ANB angle, Wit's appraisal, and the W angle specifically, our study took a broader approach, encompassing an array of numeric cephalometric parameters (including W angle, Tau angle, HBN angle, YEN angle) along with non-numeric assessments such as growth pattern and centrographic analysis.

Dr. Gor's study identified specific ranges of the W angle associated with Class I, Class II, and Class III relationships, indicating its potential clinical relevance in categorizing malocclusions. Similarly, the present study concluded that W angle is good predictor for assessing the sagittal malocclusion.[11]Both the studies concluded that W angle is a reliable numeric parameter in measuring the sagittal discrepancies. (Table 1).

The research conducted by Dave et al[44]. aimed to introduce and validate a new cephalometric measurement called the Harsh Bhagvatiprasad Nita angle (HBN) for assessing sagittal jaw relationships with precision and reproducibility.

While both studies aimed to enhance sagittal jaw assessment in orthodontics. Dave et al. concentrated on introducing and validating a new cephalometric angle (HBN angle) for diagnosing Class I, II, and III skeletal patterns, emphasizing its specific cutoff values. Conversely, our study's focus was on the comparative reliability assessment of multiple cephalometric parameters assessments across various malocclusions to understand their accuracy in assessing sagittal jaw discrepancies.[6] In our study its is concluded that HBN angle is accurate in measuring the Sagittal class III malocclusion comparative to other sagittal numeric parameters.

Dave et al and Present study concluded the same that HBN angle is a reliable indicator in measuring the sagittal discrepancies but in present study other important identification is that HBN angle is more reliable in Class III malocclusions. (Table1).

The study by Gupta et al[14]. aimed to introduce and validate a novel cephalometric parameter, the Tau angle, as a method to assess the sagittal maxillomandibular relationship accurately. Both studies aimed to enhance the diagnosis and treatment planning of sagittal discrepancies in orthodontics. However, while Gupta et al. introduced and validated a new angle (Tau angle) specifically for demarcating among Class I, II, and III skeletal malocclusions. In Present study we find that Tau angle is a reliable indicator for measuring the sagittal discrepancies because the landmarks that are used for measuring the Tau angle are accurate and they did not change due to orthodontic treatment. (Table1).

The study conducted by Praveen Kumar Neela[16] aimed to introduce a novel cephalometric measurement, the YEN angle, to evaluate the sagittal relationship between the maxilla and mandible. In present study, we focused on assessing various cephalometric parameters, including the YEN angle, W angle, Tau angle, and HBN angle, across Class I, II, and Praveen Neela et al and present study has same conclusion that Yen angle is a reliable numeric parameter that helps in evaluating the sagittal malocclusions. (Table 1).

Conclusion

Present study was conducted to determine whether Numeric measurements has better reliability in determining the sagittal discrepancies in Konaseema population of Andhra Pradesh. The study was carried out on 90 individuals from Konaseema region between 18 -24 years and the following conclusions were drawn from the present study.

In comparison with numeric measurements like YEN, TAU, HBN and W angles among all the numeric measurements YEN angle is more reliable followed by TAU angle. YEN angle is accurate in measuring the sagittal discrepancies in comparison with other Numeric parameters.

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