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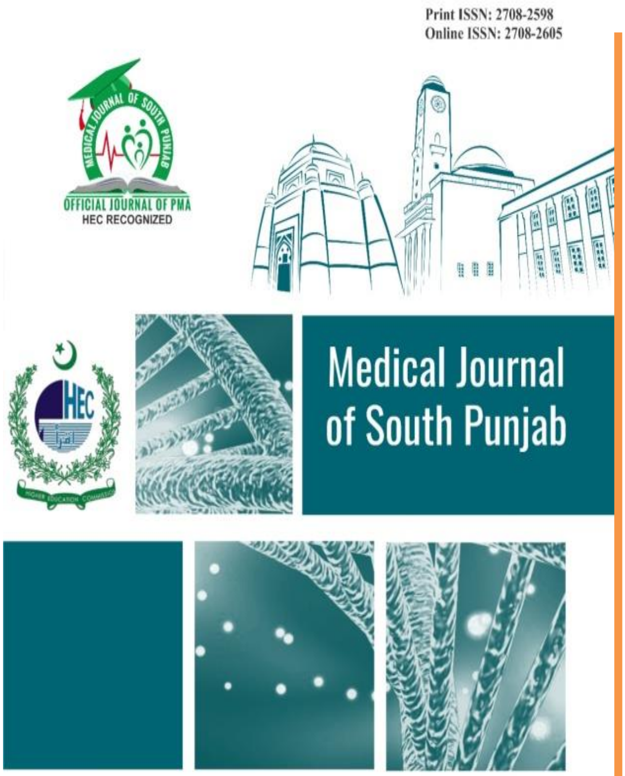

Evaluation of sagittal skeletal dysplasia by 3 cephalometric analysis methods

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Evaluation of sagittal skeletal dysplasia by 3 cephalometric analysis methods

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ABSTRACT

Objective: The study aimed to evaluate the reliability and validity of various skeletal analyses for identifying sagittal skeletal patterns.

Methods: Orthodontics department at Nishtar Institute of Dentistry, Multan. Sixty individuals aged 17 to 25 years, with skeletal Class I, II, and III patterns were enrolled. For inclusion in these classes patients had to meet specific criteria for the Beta angle along with one of two measurements: the ANB angle or the Wits appraisal. One way ANOVA was applied to check the significance of means of cephalometric parameters in all three classes. Chi-square test was applied to check the significance of accuracy of cephalometric parameters in the three classes.

Results: In Class I, sensitivity values for ANB, Wits appraisal, Beta angle, AB plane angle, Downs angle of convexity, and W angle were 82.6%, 52.2%, 69.6%, 91.3%, 95.7%, and 52.2%, respectively, with positive predictive values of 45.2%, 37.5%, 51.6%, 51.2%, 51.2%, and 44.4%. In Class II, sensitivity was 68.4%, 57.9%, 42.1%, 63.2%, 63.2%, and 47.4%, while positive predictive values were 30.9%, 34.5%, 25.8%, 29.3%, 27.9%, and 33.3%.

Conclusion: The Down's angle of convexity has been identified as the most reliable and valid indicator across all sagittal groups, with particular effectiveness in evaluating individuals with a Class I sagittal pattern. Meanwhile, the ANB angle and the AB angle serve as reliable indicators for assessing sagittal discrepancies, making them useful tools for identifying Class II and Class III sagittal patterns.

Keywords: Cephalometric parameters, Displasia, Sagittal, Jaw, Angles

1. INTRODUCTION

Variability in craniofacial development in the different plans can lead to different malocclusions. Sagittal malocclusions have significant aesthetic, psychological, and functional effects, making them a primary concern in orthodontics[1]. These malocclusions often arise from discrepancies in the growth of the maxilla or mandible. Malocclusion that was anterior to the mandible relative to the maxilla leads to concave, and malocclusion anterior to the maxilla relative to the mandible is labeled as convex[2]. Radiographs are essential for evaluating discrepancies in the skeletal sagittal plane, with standardized lateral cephalograms being the classic diagnostic tool for assessing relationships among skeletal, dental, and soft tissue structures[3].

Broadbent's standardization of cephalograms has simplified the diagnosis of anteroposterior skeletal issues[4]. Various cephalometric analyses assess sagittal skeletal discrepancies, such as the AB plane angle and the ANB angle introduced by Riedel and popularized by Steiner[5]. However, these measurements of different anglescan be sensitive to minimalchanges in reference points and position. To address this, Jacobson described the different angle of Wits appraisal, which uses reference angle of occlusal plane[6]. However, its reliability has yet to be questioned due to variability in occlusal plane identification. New parameters like W angle and Beta angle have been introduced to improve the diagnosis of sagittal discrepancies, though their validity still needs to be examined[7].

Previously, numerous studies have been conducted to correlate various cephalometric measurements and assess discrepancies in the anteroposterior jaw[8,9]. However, more research is needed on the reliability and efficacy of parameters in anteroposterior skeletal dysplasia. This leads to complex parameters that complicate cephalometric analysis and may yield conflicting results.

To address these challenges, this study was undertaken to indicate a novel method for evaluating the apical base relationship, allowing for a more accurate assessment of the underlying discrepancy. Additionally, the study aimed to determine whether the discrepancy arises from a prognathic (forward-positioned) or retrognathic (backward-positioned) jaw, thus providing a clearer diagnostic understanding and helping guide appropriate treatment planning for patients with jaw misalignments.

2. METHODOLOGY

A total of 60 cephalograms from lateral view before treatment were meticulously selected from individuals aged 17 to 25 years, encompassing a range of skeletal patterns classified as Class I, II, and III at the Orthodontics department at Nishtar Institute of Dentistry in Multan. To ensure the accuracy of the lateral cephalometric radiographs, a specialized cephalogram equipped with a mirror eye and an accurate vertical reference was employed to capture the images of all subjects in a natural head position (NHP). Before imaging, a split-level bubble device was strategically positioned between the subjects' eyebrows and hairline to verify that they maintained the correct NHP. Each participant was instructed to stand upright with their arms comfortably at their sides while gazing into the mirror of the cephalostat. They adjusted their head tilt until the bubble within the device aligned perfectly in the middle, confirming the correct head position for accurate radiographic assessment.
To be classified into the skeletal Class I, II, or III pattern groups, patients were required to satisfy specific criteria related to the Beta angle in conjunction with one of two additional measurements: the ANB angle or the Wits appraisal. For a skeletal Class I relationship, the criteria included an ANB angle ranging from 2 to 4 degrees, a Wits

appraisal indicating either a coincidence of AO and BO in female patients or BO positioned 1 mm ahead of AO in male patients, and a Beta angle measuring between 27 and 35 degrees.

A skeletal Class II relationship was identified in patients by evaluating specific cephalometric measurements. This classification was indicated by an ANB angle exceeding 4 degrees, a Wits appraisal in which the point AO was positioned ahead of point BO in females or coinciding with or ahead of BO in males, and a Beta angle measuring < 27^0.[10]

Skeletal Class III individuals were identified by an ANB angle of <2^0, a Wits measurement with BO ahead of AO in females or more than 1 mm in males, and a >35^0 Beta angle.[11]

Using SPSS version 27, frequencies and percentages were calculated for categorical variables, whereas mean and standard deviation were calculated for numerical variables. One-way ANOVA was applied to check the significance of means of cephalometric parameters in all three classes. The chi-square test was used to check the importance of the accuracy of cephalometric parameters in the three classes. P-value ≤0.050 is considered significant.

3. RESULTS

The study included 60 patients, with 23 (38.3%) in Class I, 19 (31.7%) in Class II, and 18 (30%) in Class III. The mean age was 24.17±5.54 years, comprising 35 (58.3%) males and 25 (41.7%) females (Figure I). Significant differences were found across classes (p<0.001, Table I). ANB diagnosed 82.6%, 68.4%, and 55.6% in classes I, II, and III, respectively (p=0.169). Wits appraisal accuracy was 52.2%, 57.9%, and 50.0% (p=0.882). Beta angle accuracy was 69.6%, 42.1%, and 38.9% (p=0.090). AB plane angle accuracy was 91.3%, 63.2%, and 44.4% (p=0.005). Downs angle of convexity was diagnosed at 95.7%, 63.2%, and 50.0% (p=0.003). W angle accuracy was 52.2%, 47.4%, and 33.3% (p=0.470) (Table II).

In Class I, the sensitivity of ANB, Wits appraisal, Beta angle, AB plane angle, Downs angle of convexity, and W angle was 82.6%, 52.2%, 69.6%, 91.3%, 95.7%, and 52.2%, respectively. The positive predictive value (PPV) for these measures in Class I was 45.2% for ANB, 37.5% for Wits appraisal, 51.6% for Beta angle, 51.2% for AB plane angle, 51.2% for Downs angle of convexity, and 44.4% for W angle.

In Class II, the sensitivity of ANB, Wits appraisal, Beta angle, AB plane angle, Downs angle of convexity, and W angle was 68.4%, 57.9%, 42.1%, 63.2%, 63.2%, and 47.4%, respectively. The PPV for Class II was 30.9% for ANB, 34.5% for Wits appraisal, 25.8% for Beta angle, 29.3% for AB plane angle, 27.9% for Downs angle of convexity, and 33.3% for W angle.

In Class III, the sensitivity values for ANB, Wits appraisal, Beta angle, AB plane angle, Downs angle of convexity, and W angle were 55.6%, 50.0%, 38.9%, 44.4%, 50.0%, and 33.3%, respectively. The PPV in Class III was 23.8% for ANB, 28.1% for Wits appraisal, 22.6% for Beta angle, 19.5% for AB plane angle, 20.9% for Downs angle of convexity, and 22.2% for W angle.

Figure. No. I
Gender distribution of the study

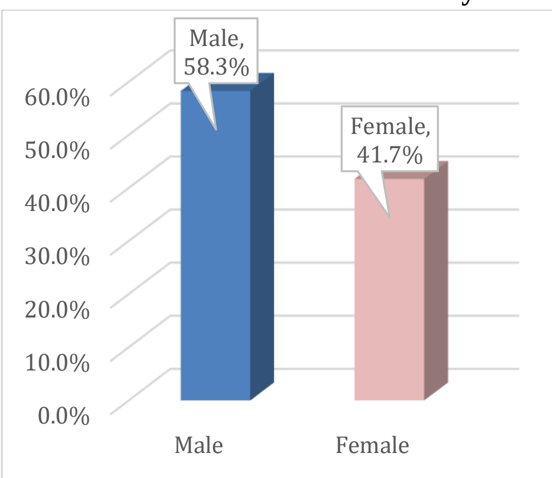

Table. No. I
Distribution of cephalometric parameters in three classes

Parameter	Class-I n=23	Class-II n=19	Class-III n=18	p
ANB	1.77±1.39	6.74±1.22	-2.90±1.68	<0.001
Wits appraisal	0.56±0.39	5.20±2.78	-7.88±1.98	<0.001
Beta angle	30.75±3.68	28.24±4.14	46.54±4.48	<0.001
AB plane angle	-5.95±2.23	- 11.36±2.14	2.78±2.52	<0.001
Downs angle of convexity	4.46±1.85	12.01±2.90	-4.42±3.42	<0.001
W angle	56.52±4.05	52.67±2.25	63.70±4.94	<0.001

Table. No. II
Correctly diagnosed cases of cephalometric parameters in three classes

Parameter	Class-I n=23	Class-II n=19	Class-III n=18	p
	Correctly diagnosed cases			
ANB	19 (82.6%)	13 (68.4%)	10 (55.6%)	0.169
Wits appraisal	12 (52.2%)	11 (57.9%)	9 (50.0%)	0.882
Beta angle	16 (69.6%)	8 (42.1%)	7 (38.9%)	0.090
AB plane angle	21 (91.3%)	12 (63.2%)	8 (44.4%)	0.005
Downs angle of convexity	22 (95.7%)	12 (63.2%)	9 (50.0%)	0.003
W angle	12 (52.2%)	9 (47.4%)	6 (33.3%)	0.470

Table. No. III
Sensitivity and positive predictive value of cephalometric parameters in three classes

Parameter	Class-I n=23		Class-II n=19		Class-III n=18	
	Sensitivity	PPV	Sensitivity	PPV	Sensitivity	PPV
ANB	82.6%	45.2%	68.4%	30.9%	55.6%	23.8%
Wits appraisal	52.2%	37.5%	57.9%	34.5%	50.0%	28.1%
Beta angle	69.6%	51.6%	42.1%	25.8%	38.9%	22.6%
AB plane angle	91.3%	51.2%	63.2%	29.3%	44.4%	19.5%
Downs angle of convexity	95.7%	51.2%	63.2%	27.9%	50.0%	20.9%
W angle	52.2%	44.4%	47.4%	33.3%	33.3%	22.2%

4. DISCUSSION

The cephalometric measurementof jaw relationships in the sagittal plane is essential in orthodontics. Since Broadbent introduced lateral cephalometry, various analyses have been developed to assess the AP relationship of the jaws[12]. However, in borderline cases, these skeletal analyses can yield conflicting results, making it challenging to diagnose the sagittal skeletal pattern[13].

In this study, the ANB method accurately diagnosed 19 cases (82.6%) in Class I, 13 cases (68.4%) in Class II, and 10 cases (55.6%) in Class III, yielding a p-value of 0.169. In contrast, the Wits appraisal demonstrated correct diagnoses in 12 cases (52.2%) for Class I, 11 cases (57.9%) for Class II, and 9 cases (50.0%) for Class III. Ishikawa et al[14] concluded a strong negative correlation between Downs angle of convexity and the AB plane angle and an even stronger one with the ANB angle (r = -0.95). They also found a positive correlation between the ANB angle and the Downs angle of convexity (r = 0.97). These variations may stem from sample size differences and the exclusive inclusion of Class I subjects. Similarly, Gule-Erum et al[15] found a significant correlation between the AB plane and ANB angles, consistent with the present study.

In our study, the Downs angle of convexity showed the highest diagnostic accuracy, correctly diagnosing 22 (95.7%), 12 (63.2%), and 9 (50.0%) in Class I, II, and III, respectively, which was significantly better than Wits appraisal, Beta angle, and ANB (p=0.003). The W angle correctly diagnosed 12 (52.2%), 9 (47.4%), and 6 (33.3%) in Class I, II, and III, respectively (p=0.470). Kumar and Sundareswaran[16] also found the W angle analysis more reliable than the Wits appraisal, ANB angle, and Beta angle as it avoids points locating difficulty of A, B, and N, the functional occlusal plane, and the condylar axis.

Ali et al[17] found that W angle analysis closely aligns with ANB angle and Wits appraisal in Class I defects. However, they questioned W angle's effectiveness in assessing sagittal jaw relationships for Class II and III defects. They concluded that ANB, beta, and Wits are more reliable for these cases, with ANB considered the gold standard for sagittal discrepancy assessment.

Hatewar et al[18] demonstrated a significant consistency in evaluating the sagittal relationships of jaw bases. Traditional measurements, widely regarded as authoritative for assessing these relationships, often need to be more accurate due to their reliance on various angular and linear measurements connected to the positions of points N, A, and B.

Shetty et al[19] systematically reviewed 21 studies on the anteroposterior discrepancy, confirming the value of W angle analysis and found W angle reliable measure of the sagittal measurement relationship between mandible and maxilla. While ANB, Wits, and beta angles are often seen as gold standards, W angle analysis proved more reliable in this context. A study conducted on the Pakistani population compared various cephalometric analyses measurerelationship with sagittal jaw. The results showed statistically significant correlations among seven different methods despite variations in the strength of association. The findings suggest that, besides the established ANB angle, the Facial Axis of Björk Analysis (FABA) and the A-B plane can be helpful to predictors of skeletal class[20].

5. CONCLUSION

Down's angle of convexity has been identified as the most reliable and valid indicator across all sagittal groups, and it is particularly effective in evaluating individuals with a Class I sagittal pattern. Meanwhile, the ANB and AB angles are reliable indicators for assessing sagittal discrepancies, making them valuable tools for identifying Class II and III sagittal patterns.

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