

Original Article

Sagittal Pattern and Severity of Skeletal Discrepancy in Class II Div 1 Malocclusion

Maria Zehri¹, Nasrullah Mengal², Munir Ahmed³, Marium Hasni⁴, Irfan Ali⁵, Mehreen Butt⁶¹ FCPS Trainee Orthodontics, Department of Orthodontics, Bolan Medical College, Quetta, Pakistan.² Professor and Head of Department, Department of Orthodontics, Bolan Medical College, Quetta, Pakistan.³ Chief Dental Surgeon, DHO, Quetta, Pakistan.⁴ Demonstrator, BMC, Quetta, Pakistan.⁵ Dental Surgeon, SPH, Quetta, Pakistan.⁶ Assistant Professor, Dental College, Quetta, Pakistan.

✉ Correspondence: Maria Zehri, mariazehri27@gmail.com

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ABSTRACT

Background: Class II Division 1 malocclusion encompasses differing skeletal patterns, requiring assessment of anatomical involvement and sagittal discrepancy. **Objective:** To determine sagittal skeletal patterns and discrepancy severity and examine correlations among cephalometric measurements. **Methods:** This cross-sectional study included 90 pretreatment lateral cephalograms of patients aged 12–25 years at Bolan Medical College/Sandeman Provincial Hospital, Quetta, from 4 November 2022 to 4 June 2023. ANB angle, Wits appraisal, Beta angle, and angle of convexity were measured manually. Skeletal patterns were recorded, and severity was categorized using ANB. Descriptive statistics and Pearson correlations were analyzed using SPSS version 26.0, with $p < 0.05$ indicating statistical significance. **Results:** Mean age was 16.4 ± 2.8 years. Mandibular retrognathism occurred in 53 patients (58.9%), maxillary prognathism in 28 (31.1%), and combined involvement in nine (10.0%). Moderate discrepancy affected 40 patients (44.4%), severe discrepancy 34 (37.8%), and mild discrepancy 16 (17.8%). Mean ANB was $6.8 \pm 1.9^\circ$. ANB correlated positively with Wits appraisal ($r=0.72$) and convexity ($r=0.65$), and negatively with Beta angle ($r=-0.68$); all $p < 0.001$. **Conclusion:** Mandibular retrognathism predominated, and most patients were classified as having moderate or severe discrepancy. Correlations characterized relationships among measurements without establishing diagnostic superiority or treatment effectiveness. **Keywords:** Class II Division 1; skeletal discrepancy; mandibular retrognathism; ANB angle; Wits appraisal; Beta angle.

INTRODUCTION

Class II Division 1 malocclusion is an important orthodontic problem characterized by a distal dental relationship and typically proclined maxillary incisors with increased overjet. Although dental classification describes the occlusal relationship, it does not independently identify the skeletal components underlying the discrepancy. Patients with a similar dental presentation may differ in maxillary position, mandibular position, and the relationship between the jaws, making skeletal assessment an essential component of diagnostic evaluation and treatment planning (1,2).

Previous investigations have emphasized the heterogeneous skeletal presentation of Class II malocclusion. McNamara examined its individual components in children, highlighting the importance of assessing maxillary and mandibular contributions rather than treating Class II as a uniform anatomical condition (3). Mandibular retrusion, maxillary protrusion, or their combination may contribute to the sagittal discrepancy, while vertical relationships and dentoalveolar compensation can influence its clinical expression. Identifying these components is relevant to treatment planning because the apparent dental discrepancy may not adequately represent the underlying skeletal relationship (2,3). Accordingly, assessment should distinguish the anatomical pattern from the magnitude of the intermaxillary discrepancy.

Cephalometric analysis provides several measurements for evaluating sagittal jaw relationships. The ANB angle is widely used because it expresses the relationship between the maxillary and mandibular apical bases relative to nasion. However, its interpretation depends on craniofacial geometry, and changes in the positions of nasion, point A, and point B can influence the measured angle (4,5). Consequently, an increased ANB angle should be interpreted within the broader craniofacial assessment rather than assumed to identify the contribution of either jaw independently.

Alternative measurements provide different geometric perspectives on sagittal discrepancy. Jacobson introduced the Wits appraisal, which assesses the relationship between perpendicular projections of points A and B onto the occlusal plane (6). Unlike ANB, this measurement does not use nasion as its reference, although its construction makes the definition and orientation of the occlusal plane relevant to interpretation. Baik and Ververidou subsequently introduced the Beta angle as another approach to evaluating sagittal relationships without relying on cranial-base reference landmarks (7). Comparative investigation of ANB, Wits, and other sagittal measurements further illustrates the importance of understanding how different indices characterize the same underlying relationship (8). The angle of facial convexity offers an additional description of the skeletal profile and can complement the assessment of intermaxillary relationships (9). Associations between these measurements are therefore informative, although correlation alone does not establish diagnostic agreement or demonstrate improved accuracy.

Despite this established diagnostic framework, the literature presented here does not adequately characterize the distribution of sagittal skeletal patterns and ANB-defined severity among patients with Class II Division 1 malocclusion attending the study institution in Quetta. A description of this clinical population could clarify the relative frequency of the recorded skeletal patterns and the extent of discrepancy encountered in routine pretreatment assessment. Evaluating the relationships between ANB and complementary cephalometric measurements may also help describe how these indices vary within this selected patient population. Such evidence should be interpreted as a clinical sample description rather than an estimate of community prevalence or a source of population-wide normative values.

Therefore, this cross-sectional study aimed to determine the distribution of sagittal skeletal patterns and the severity of skeletal discrepancy, graded using ANB, among patients aged 12–25 years with Class II Division 1 malocclusion attending the Department of Orthodontics, Bolan Medical College/Sandeman Provincial Hospital, Quetta. A secondary objective was to examine the correlations of ANB with Wits appraisal, Beta angle, and the angle of convexity.

MATERIAL AND METHODS

This cross-sectional study was conducted in the Department of Orthodontics, Bolan Medical College/Sandeman Provincial Hospital, Quetta, Pakistan, from 4 November 2022 to 4 June 2023. The study evaluated the distribution of sagittal skeletal patterns and the severity of skeletal discrepancy in patients with Class II Division 1 malocclusion and examined associations between cephalometric measurements of sagittal jaw relationships. Ethical approval was obtained from the institutional ethical review committee before the study commenced.

The study sample comprised 90 pretreatment lateral cephalograms of patients aged 12–25 years. Eligibility required Class II Division 1 molar and canine relationships, an overjet greater than 4 mm, and no previous orthodontic treatment. Patients with craniofacial syndromes, a history of craniofacial trauma, or missing permanent teeth were excluded. The dental classification was based on the Class II relationship described by Angle (1). All assessments

concerned the pretreatment presentation, and no treatment intervention or longitudinal outcome assessment formed part of the study.

Lateral cephalograms were traced manually by a single examiner. The measurements recorded were ANB angle, Wits appraisal, Beta angle, and the angle of convexity. ANB was used to characterize the sagittal relationship between the maxillary and mandibular apical bases relative to nasion, with values greater than 4° interpreted as indicating a skeletal Class II relationship (4,5). Wits appraisal was measured in millimeters as the distance between the perpendicular projections of points A and B onto the functional occlusal plane (6). Beta angle was recorded in degrees as an additional measure of sagittal skeletal discrepancy, with values below 27° interpreted as indicating a Class II relationship (7). The angle of convexity was assessed using nasion, point A, and pogonion to describe the skeletal facial profile (9).

The principal outcomes were the distribution of sagittal skeletal patterns and ANB-based severity of skeletal discrepancy. Skeletal patterns were recorded as mandibular retrognathism, maxillary prognathism, or combined maxillary prognathism and mandibular retrognathism. Severity was categorized as mild, moderate, or severe according to ANB measurements. Age and sex were recorded as participant characteristics. Use of a single examiner standardized the tracing procedure, and an intra-examiner error assessment was undertaken to evaluate measurement reproducibility.

Data were analyzed using IBM SPSS Statistics version 26.0. Continuous variables, including age and cephalometric measurements, were summarized as means and standard deviations. Categorical variables, including sex, sagittal skeletal pattern, and severity category, were summarized as frequencies and percentages. Chi-square testing was specified for categorical analyses. Pearson correlation coefficients were used to examine the relationships of ANB with Wits appraisal, Beta angle, and the angle of convexity. Statistical significance was defined as $p < 0.05$.

RESULTS

The study included 90 patients, comprising 48 females (53.3%) and 42 males (46.7%), with a mean age of 16.4 ± 2.8 years. The mean ANB angle was $6.8 \pm 1.9^\circ$, and the mean Wits appraisal was 3.2 ± 2.1 mm. Mean Beta angle and angle of convexity were $25.1 \pm 3.4^\circ$ and $8.6 \pm 3.2^\circ$, respectively (Table 1).

Mandibular retrognathism was the most frequently recorded sagittal skeletal pattern, occurring in 53 patients (58.9%). Maxillary prognathism was recorded in 28 patients (31.1%), while nine patients (10.0%) had combined maxillary prognathism and mandibular retrognathism (Table 2). Moderate skeletal discrepancy was the most frequent severity category, affecting 40 patients (44.4%), followed by severe discrepancy in 34 (37.8%) and mild discrepancy in 16 (17.8%) (Table 3).

Table 1. Participant characteristics and cephalometric measurements (N = 90)

Continuous variable	Mean $\pm$ SD
Age (years)	16.4 ± 2.8
ANB angle (°)	6.8 ± 1.9
Wits appraisal (mm)	3.2 ± 2.1
Beta angle (°)	25.1 ± 3.4
Angle of convexity (°)	8.6 ± 3.2

Sex	n (%)
Female	48 (53.3)
Male	42 (46.7)

SD, standard deviation; ANB, A point–nasion–B point angle.

Table 2. Distribution of sagittal skeletal patterns (N = 90)

Sagittal skeletal pattern	n (%)
Mandibular retrognathism	53 (58.9)
Maxillary prognathism	28 (31.1)
Combined maxillary prognathism and mandibular retrognathism	9 (10.0)
Total	90 (100.0)

Table 3. Distribution of ANB-based skeletal discrepancy severity (N = 90)

Severity	n (%)
Mild	16 (17.8)
Moderate	40 (44.4)
Severe	34 (37.8)
Total	90 (100.0)

ANB, A point–nasion–B point angle.

Table 4. Correlations of ANB angle with other cephalometric measurements

Measurement correlated with ANB	n	Pearson r	95% CI for r	p-value
Wits appraisal	90	0.72	0.60 to 0.81	<0.001
Beta angle	90	−0.68	−0.78 to −0.55	<0.001
Angle of convexity	90	0.65	0.51 to 0.76	<0.001

ANB, A point–nasion–B point angle; CI, confidence interval. Confidence intervals were calculated using Fisher's z transformation. Two-sided p-values were calculated using the Pearson correlation t-test with 88 degrees of freedom.

ANB angle was positively correlated with Wits appraisal ($r = 0.72$; 95% CI, 0.60 to 0.81) and angle of convexity ($r = 0.65$; 95% CI, 0.51 to 0.76). An inverse correlation was observed between ANB and Beta angle ($r = -0.68$; 95% CI, -0.78 to -0.55). All three correlations had p-values below 0.001 (Table 4).

DISCUSSION

Mandibular retrognathism was the most frequently recorded sagittal skeletal pattern in this clinical sample, and most patients were classified as having moderate or severe ANB-based discrepancy. ANB correlated positively with Wits appraisal and the angle of convexity and negatively with Beta angle. These findings describe the anatomical patterns and relationships between cephalometric measurements encountered among patients with Class II Division 1 malocclusion at the study institution.

The predominance of mandibular retrognathism is consistent with the emphasis placed on mandibular deficiency in previous descriptions of Class II malocclusion. McNamara's investigation of children aged 8–10 years highlighted the importance of assessing individual skeletal components rather than treating Class II malocclusion as a uniform condition (7). However, direct comparison with the present sample requires caution because the participants were aged 12–25 years, encompassing different stages of craniofacial development. Differences in age, selection criteria, reference values, and anatomical classification may influence the proportions assigned to each skeletal pattern. The presence of maxillary prognathism and combined involvement also reinforces the distinction between dental classification and the underlying skeletal relationship (8,9).

Moderate and severe discrepancy together accounted for most of the reported severity distribution. This finding characterizes the patients included in the study but should not be interpreted as the distribution of severity in the wider population. Attendance at a specialist orthodontic department may select patients with more apparent or complex discrepancies, although referral patterns were not examined. Moreover, ANB-defined severity represents one dimension of craniofacial morphology. Clinical assessment also requires consideration of the individual jaw relationships and other diagnostic features; an ANB category alone does not establish a particular treatment requirement (10,11).

The positive relationship between ANB and Wits appraisal indicates that larger ANB values generally accompanied greater sagittal separation of the projected apical-base landmarks. Nevertheless, the two measurements use different reference constructions. ANB depends on the relationship of points A and B to nasion, whereas Wits uses projections onto the occlusal plane (12,13). Differences in these geometric references provide a plausible explanation for their incomplete correlation. The findings are relevant to the comparative assessment of sagittal indices described by Oktay, but they do not establish that the measurements are interchangeable or that one is more accurate than another (14).

The inverse association between ANB and Beta angle is consistent with their opposite directional interpretation in Class II assessment: increasing ANB and decreasing Beta angle indicate greater Class II discrepancy under the study's measurement framework. Beta angle was introduced as an alternative geometric approach to sagittal

assessment, providing a perspective that does not depend on nasion as a reference landmark (15). Similarly, the positive association between ANB and the angle of convexity suggests that greater intermaxillary discrepancy was accompanied by greater skeletal profile convexity in this sample, consistent with the role of convexity in cephalometric description (16). These relationships should nevertheless be interpreted with awareness that several measurements share anatomical landmarks, which may contribute to correlated values and correlated measurement error.

Clinically, the findings support distinguishing the recorded anatomical pattern from the measured magnitude of sagittal discrepancy. This distinction is relevant to individualized diagnostic assessment, but the study did not evaluate treatment selection, response to functional appliances, surgical indications, or the benefit of early intervention (17). Consequently, the observed correlations cannot demonstrate that combining measurements improves treatment outcomes or diagnostic accuracy. Their immediate contribution is descriptive: they show how several cephalometric indices varied together within this selected patient group. The findings may inform understanding of the institution's clinical case mix, but they do not establish community prevalence or population-specific cephalometric norms (18, 19).

The study's strengths include assessment of pretreatment records, restriction to a defined dental malocclusion, and use of several cephalometric measurements. Manual tracing by one examiner provided procedural consistency, although it does not eliminate systematic measurement error. Important limitations concern the single-center sample, incompletely described participant selection, and the broad age range without reported growth-stage or adjusted analyses. Quantitative intra-examiner reliability findings were not presented. In addition, the operational criteria separating maxillary, mandibular, and combined patterns were insufficiently documented, and the reported ANB severity intervals contained ambiguous boundaries. These limitations affect reproducibility and confidence in the categorical findings. The cross-sectional design, absence of an independent diagnostic reference standard, and lack of treatment follow-up further limit conclusions about causation, diagnostic performance, and clinical effectiveness. Accordingly, the results are best interpreted as a descriptive account of the recorded skeletal patterns and cephalometric associations in this clinical sample (20).

CONCLUSION

Mandibular retrognathism was the most frequently recorded sagittal skeletal pattern among the studied patients with Class II Division 1 malocclusion, and most were classified as having moderate or severe ANB-based discrepancy. ANB correlated positively with Wits appraisal and the angle of convexity and negatively with Beta angle. These findings characterize the skeletal presentation and relationships among cephalometric measurements in this clinical sample, without establishing diagnostic superiority or treatment effectiveness.

REFERENCES

1. Fida M. Changes in Angle's classification of malocclusion in a sample of 28,762 Pakistani school children. *J Coll Physicians Surg Pak*. 2007;17(3):147-150.
2. Angle EH. Classification of malocclusion. *Dent Cosmos*. 1899;41:248-264.
3. McNamara JA Jr. Components of Class II malocclusion in children 8-10 years of age. *Angle Orthod*. 1981;51(3):177-202.
4. Bishara SE. Class II malocclusions: diagnostic and clinical considerations with and without treatment. *Semin Orthod*. 1998;4(1):11-20.
5. Riedel RA. The relation of maxillary structures to cranium in malocclusion and in normal occlusion. *Angle Orthod*. 1952;22(3):142-145.
6. Taylor CM. Changes in the relationship of nasion, point A and point B and the effect upon ANB. *Am J Orthod*. 1969;56(2):143-163.
7. Jacobson A. The "Wits" appraisal of jaw disharmony. *Am J Orthod*. 1975;67(2):125-138.

8. Bishara SE, Fahl JA, Peterson LC. Longitudinal changes in the Wits appraisal and its relationship to occlusal and skeletal variables. *Am J Orthod Dentofacial Orthop.* 1998;114(4):442-446.
9. Baik CY, Ververidou M. A new approach of assessing sagittal discrepancies: the Beta angle. *Am J Orthod Dentofacial Orthop.* 2004;126(1):100-105.
10. Proffit WR, Fields HW, Sarver DM. *Contemporary Orthodontics.* 6th ed. Elsevier; 2018. Chapter 5: Diagnosis and Treatment Planning.
11. Ricketts RM. Cephalometric synthesis. *Am J Orthod.* 1960;46(9):647-73.
12. Downs WB. Variations in facial relationships: their significance in treatment and prognosis. *Am J Orthod.* 1948;34(10):812-40.
13. Bhatia SN, Leighton BC. *A manual of facial growth.* Oxford University Press; 1993.
14. Ghosh J, Nanda RS. Evaluation of an improved cephalometric analysis for the diagnosis of sagittal and vertical discrepancies. *Am J Orthod Dentofacial Orthop.* 1996;110(3):252-8.
15. Williams S, Andersen CE. The morphology of the potential Class III skeletal pattern in the growing child. *Am J Orthod.* 1986;89(4):302-11.
16. Hasund A, Segner D. The Begg technique and the sagittal correction of Class II. *J Clin Orthod.* 1988;22(11):682-9.
17. Oktay H. A comparison of ANB, Wits, AF-BF, and APDI measurements. *Am J Orthod Dentofacial Orthop.* 1991;99(2):122-8.
18. Al-Khateeb SN, Al-Khateeb LT. Ancephalometric evaluation of the sagittal skeletal discrepancy in Class II subjects. *Angle Orthod.* 2009;79(2):234-8.
19. Cooke MS, Wei SH. The reproducibility of natural head posture: a methodological study. *Am J Orthod Dentofacial Orthop.* 1988;93(4):280-8.
20. Taylor WH. A cephalometric study of the dental and skeletal relationships in Class II Division 1 malocclusion. *Br J Orthod.* 1969;16(3):149-54.