

The Impact of Gonial Angle on Skeletal Class II Division 1 Malocclusion: A Cephalometric Study

Ahmed Ben Omran 

Althager Dental Center, Misrata, Libya

Corresponding Email. ahmedbenomran349@gmail.com

Abstract

The gonial angle plays a crucial role in craniofacial morphology and directly affects mandibular positioning and growth patterns, and overall mandibular shape. This study aims to analyze the relationship between the gonial angle and skeletal class II division 1 malocclusion, emphasizing its impact on skeletal discrepancy between the maxilla and the mandible, both horizontally and vertically. A total of 116 lateral cephalographs 56 males and 60 females of Libyan White Ancient population patients diagnosed with skeletal class II division 1, were analyzed using Dr.Ceph software (Fytik Co.) Eighteen skeletal measurements were assessed, with focus on the gonial angle (Ar-Go-Me) and correlation with ANB, SNB, and mandibular plane angle(SN-MP). Statistical analysis was done using SPSS 12.0 software (Lead Technology Co.). The measurement of the study sample was compared with the normal values of the Libyan population, including Pearson correlation analysis and t-tests to determine the significance of gonial angle effects. The results showed a significantly larger gonial angle observed in patients with class II Div1 malocclusion compared to normal cephalometric values for Libyans ($p < 0.01$). The gonial angle demonstrates a positive correlation with ANB ($r = 0.287$, $p = 0.002$) and mandibular plane angle ($r = 0.352$, $p < 0.001$), and a negative correlation with SNB ($r = -0.297$, $p = 0.001$). These findings suggest that the increased gonial angle is associated with mandibular retrusion, steeper mandibular plane, clockwise (downward) rotation of the mandible, and increased lower facial height leading to a more pronounced class II skeletal relationship.

Keywords: Cephalometrics, Gonial Angle. Class II Malocclusion, Mandibular Rotations.

Received: 15/02/25

Accepted: 11/04/25

Published: 19/04/25

Copyright © Khalij-Libya Journal (KJDMR) 2025. Open Access. Some rights reserved. This work is available under the CC BY-NC-SA 3.0 IGO license.

Introduction

Skeletal class II malocclusion is primarily characterized by a discrepancy between the maxilla and the mandible, which can be due to mandibular retrusion, maxillary protrusion, or a combination of both [1,2]. The gonial angle (Ar-GO-Me) is a critical cephalometric measurement that influences mandibular growth direction and rotation, playing a key role in the development of skeletal class II malocclusions [3,4]. A larger gonial angle is associated with a more vertical growth pattern and an increased tendency for mandibular retrusion.

The purpose of this study is to investigate the influence of the gonial angle on skeletal class II division 1 malocclusion and its correlation with important cephalometric measurements in Libyan patients, comparing them with normal values for the Libyan population [5]. Understanding this relationship will help orthodontists refine their treatment plan, particularly for cases requiring mandibular advancement or orthopedic corrections.

Methods

The study was conducted at Althager Orthodontic Center, Misrata, Libya, and included 116 lateral cephalometric radiographs of patients diagnosed with skeletal class II division 1 malocclusion ($ANB \geq 4$). The sample consists of 56 males (mean age 18.2 ± 5.2 yrs.) and 60 females (mean age 19.4 ± 5.6 yrs). The inclusion criteria include: patients of the white Libyan ancient population, diagnosis of skeletal class II division 1 malocclusion (ANB angle ≥ 4). Radiographs were taken by the author using Strato X 2000 (Villa Medical Systems- Italy) with teeth in centric occlusion. Digital cephalometric analysis was performed using Dr. Ceph software (Fytik Co. USA), measuring the gonial angle (mandibular growth direction and rotation Ar-GO-Me), ANB (sagittal skeletal discrepancy), SNB (Mandibular position relative to the cranial base, Mandibular plane angle (SN-MP growth pattern assessment) Fig 1, 2.

Statistical analysis was done using SPSS 12.0 software, with Pearson correlation and independent t-tests applied to examine the relationship between gonial angle and other cephalometric parameters.

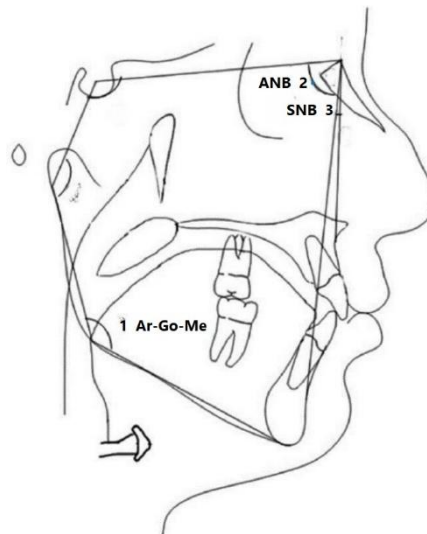


Figure 1. Gonial angle (Ar-Go-Me), the ANB and SNB angles

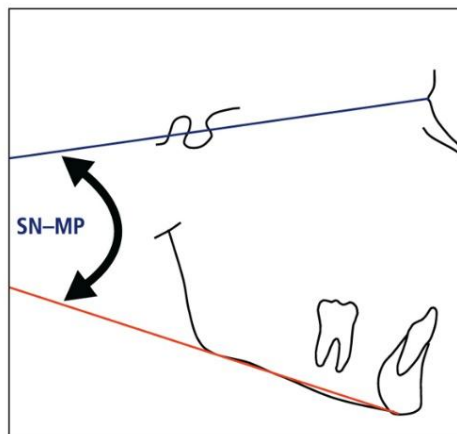


Figure 2. The mandibular plane angle

Results

The mean gonial angle in class II division 1 patients was significantly larger than the normal Libyan cephalometric values ($p < 0.01$), Table 1 and Bar Chart 1. The findings indicate that there is a strong negative correlation between ANB and SNB ($r = -0.309$, $p = 0.001$) (Table 2). A larger gonial angle correlates positively with ANB ($r = 0.278$, $p = 0.002$), increasing the severity of the class II skeletal relationship. A negative correlation exists between the gonial angle and SNB ($r = 0.297$, $p < 0.001$), Tables 3,4, suggesting that as the gonial angle increases, mandibular retrusion becomes more pronounced. A strong correlation was found between the gonial angle and the mandibular plane angle ($r = 0.352$, $p < 0.001$), Table 5, confirming that a large gonial angle is linked to a vertical mandibular growth pattern and clockwise rotation. Table 6 shows the correlation between SNB and both the gonial and the mandibular plane angles.

Table 1: Mean cephalometric values in class II patients vs. normal values

Measurement	Class II Patients (Mean $\pm$ SD)	Normal Values (Mean $\pm$ SD)	p-Value
Ar-GO-Me	146.28 $\pm$ 7.56	121.55 $\pm$ 6.8	<0.001
ANB angle	6.1 $\pm$ 1.3	2.0 $\pm$ 1.5	<0.001
SNB angle	74.3 $\pm$ 3.2	78.0 $\pm$ 2.5	<0.01
Mandibular plane angle (SN-MP)	38.4 $\pm$ 4.7	32.0 $\pm$ 3.8	<0.01

Table 2: Pearson correlation between ANB to SNB

Pearson correlation	Pearson Correlation (r)	Significance (2-tailed)
ANB/SNB	-0.309**	0.001

** Correlation is significant at the 0.01 level.

Table 3: The Pearson correlation between articular angle and ANB angle

Pearson correlation	ANB
Ar-Go-Me	r=0.278

** Correlation is significant at the 0.002 level.

Table 4: The Pearson correlation between articular angle and mandibular plane angle

Pearson correlation	SNB
Ar-G0-Me	r=0.297

**Correlation is significant at the 0.002 level.

Table 5: The Pearson correlation between articular angle and mandibular plane angle

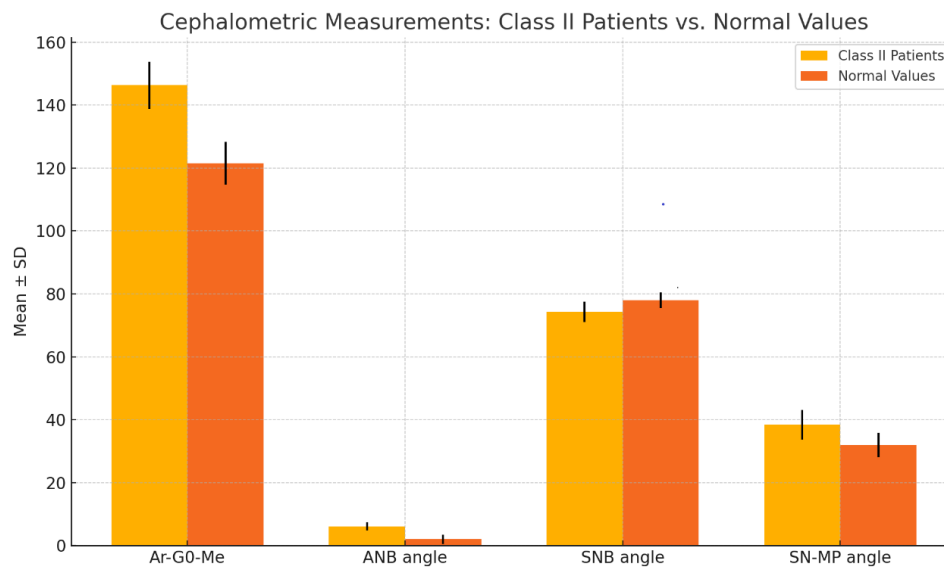
Pearson correlation	SN-MP
S-Ar=Go	-0.352**

** Correlation is significant at the 0.001 level.

Table 6: The Pearson Correlation (r) of SNB and other measurements

Pearson correlation	Pearson Correlation	Significance (2-tailed)
Ar-Go-Me	-0.300	0.001
SN-MP	-0.447**	0.000

** Correlation is significant at the 0.01 level.



Bar chart 1: Class II patients vs. normal values

Discussion

The gonial angle is a crucial determinant of mandibular morphology and growth direction [6]. A large gonial angle is associated with a more backward rotated mandible, leading to mandibular deficiency and a worsening of the Class II skeletal relationship [7,8]. Several studies have reported similar findings, highlighting the role of the gonial angle in contributing to retrognathic mandibles in Class II patients [9-11]. Increased gonial angles are also associated with high-angle facial patterns and reduced chin prominence, further exacerbating the Class II profile [12,13]. Patients with an excessive gonial angle often present with a steep mandibular plane, leading to increased anterior facial height and an unfavorable occlusal plane inclination [14-16].

These skeletal characteristics are important considerations in treatment planning. Orthopedic interventions, such as functional appliances in growing patients, can help redirect mandibular growth and counteract excessive gonial angle development [17-19]. In non-growing patients, orthognathic surgery or camouflaging orthodontic techniques may be required to manage these skeletal discrepancies effectively [20-23].

Conclusion

This study confirms that an increased gonial angle significantly contributes to the severity of skeletal Class II Division I malocclusion. The strong correlation between the gonial angle and mandibular retrusion highlights its importance in cephalometric analysis and treatment planning. Future studies should include

longitudinal data to evaluate the effects of orthopedic interventions on gonial angle modulation. Understanding the role of the gonial angle in Class II malocclusion can aid in refining treatment approaches, ensuring better functional and aesthetic outcomes for patients.

References

1. Bishara SE. Textbook of Orthodontics. Saunders; 2001.
2. Proffit WR, Fields HW, Sarver DM. Contemporary Orthodontics. 6th ed. Elsevier; 2018.
3. McNamara JA. Components of Class II malocclusion in children 8-10 years of age. *Angle Orthod.* 1981;51(3):177-202.
4. Rakosi T, Jonas I, Graber TM. Color Atlas of Dental Medicine: Orthodontic-Diagnosis. Thieme Medical Publishers; 1993.
5. Efaituri H, Ingafou M, Mutwani R. Cephalometric Norms for Libyan Population. *Garyounis Med J.* 2003;20(2):40-47.
6. Downs WB. Variations in facial relationships: Their significance in treatment and prognosis. *Am J Orthod Oral Surg.* 1948;34(10):812-840.
7. Schudy FF. The rotation of the mandible resulting from growth: Its implications in orthodontic treatment. *Am J Orthod.* 1963;49(6):446-467.
8. Creekmore TD. Inhibition or stimulation of the vertical growth of the facial complex, its significance to treatment. *Angle Orthod.* 1983;53(2):132-144.
9. Steiner CC. Cephalometrics for you and me. *Am J Orthod Oral Surg.* 1953;39(10):720-755.
10. Enlow DH, Hans MG. Essentials of Facial Growth. WB Saunders; 1996.
11. Ricketts RM. The influence of orthodontic treatment on facial growth and development. *Angle Orthod.* 1960;30(3):103-133.
12. Bjork A. Prediction of mandibular growth rotation. *Am J Orthod.* 1969;55(6):585-599.
13. Arnett GW, Gunson MJ. Facial planning for orthodontists and oral surgeons. *Am J Orthod Dentofacial Orthop.* 2010;138(6):750-757.
14. Kim YH. Overbite depth indicator: An adjunct to cephalometric differential diagnosis. *Am J Orthod.* 1974;65(6):586-612.
15. Fishman LS. Factors related to excessive vertical dimension. *Am J Orthod.* 1973;64(3):288-299.
16. Nanda R. Biomechanical and clinical considerations of a new approach to the treatment of Class II malocclusion. *Angle Orthod.* 1990;60(3):175-188.
17. Behrents RG. Growth in the aging craniofacial skeleton. Monograph 17, Craniofacial Growth Series. University of Michigan; 1985.
18. Johnston LE. Growth and the Class II patient: Rendering unto Caesar. *Angle Orthod.* 1996;66(1):1-10.
19. Tulloch JFC, Phillips C, Proffit WR. Benefit of early Class II treatment: Progress report of a two-phase randomized clinical trial. *Am J Orthod Dentofacial Orthop.* 1997;111(5):503-514.
20. McLaughlin RP, Bennet JC, Trevisi HJ. Systemized Orthodontic Treatment Mechanics. Mosby; 2001.
21. Williams S, Andersen C. The morphology of the potential Class III skeletal pattern in the growing child. *Am J Orthod Dentofacial Orthop.* 1986;89(4):302-311.
22. Park JH, Kim JH, Bayome M, Kook YA. Three-dimensional cone-beam computed tomography-based comparison of mandibular dimensions and lower incisor position in skeletal Class I and Class II malocclusions. *Angle Orthod.* 2012;82(4):610-617.
23. Baccetti T, Franchi L, McNamara JA. The cervical vertebral maturation (CVM) method for assessment of optimal treatment timing in dentofacial orthopedics. *Semin Orthod.* 2005;11(3):119-129.