Research Square

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Positional and Dimensional Characteristics of the mandible In Lebanese Class II Division 1 Skeletal Malocclusion Patients (Cross-sectional Study)

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Abstract

Objectives

This study sought to establish a morphological classification of mandibular retrognathism into positional and dimensional subtypes among patients presenting with Class II Division 1 skeletal malocclusion in a Lebanese population.

Materials and Methods

A cross-sectional study was conducted on 120 subjects (60 males, 60 females) diagnosed with Class II Division 1 malocclusion and recruited from the outpatient clinics of the Department of Orthodontics. Standardized lateral cephalometric radiographs were obtained and subjected to comprehensive analysis using validated linear and angular measurements to facilitate subtype classification.

Results

All participants demonstrated a consistent and uniform reduction in mandibular dimensions, encompassing ramal height, mandibular body length, and total effective mandibular length. Conversely, cranial base morphology revealed an increased total effective length across both genders. Statistically significant gender-based dimorphism was confined to cranial base parameters, with males exhibiting a greater total cranial base length and females demonstrating a larger cranial base angle.

Conclusion

Reduced ramal height and mandibular body length were identified universally across all participants, with a prevalence of 100%, and without statistically significant gender-based variation in the context of Class II Division 1 malocclusion.

Clinical Implications:

Clinicians are strongly encouraged to differentiate between positional retrognathism which may respond favorably to functional appliance therapy and true dimensional mandibular deficiency, which may necessitate growth modification in the mixed dentition phase or orthognathic surgical intervention in skeletally mature patients.

Introduction

A precise characterization of the skeletal and dental components contributing to a malocclusion is indispensable, as it fundamentally dictates the rationale behind treatment strategy selection.[1]

Class II malocclusion may involve dental, skeletal, and/or functional discrepancies. According to Angle's classification, it is characterized by a distal relationship of the mandibular teeth to the maxillary teeth

greater than half a cusp width. He further divided Class II malocclusion into two divisions based on the inclination of the maxillary central incisors (Bishara, 2006).[2]

In recent years, Class II malocclusion has received significant attention in orthodontics due to its prevalence and impact on oral health. Numerous studies worldwide have investigated its prevalence and characteristics to improve diagnosis and treatment planning.[2,3,4,5,6,7,8,9]

The Class II malocclusion is a common malocclusion with a prevalence ranging between 5% and 29% (Hassan, 2011). In Lebanon, Class II is the most frequent type of malocclusion with a prevalence of 19.1%.[10]

Individuals with the same type of malocclusion do not necessarily exhibit identical cephalometric features; rather, a range of characteristics may be present within each type. Class II malocclusions with skeletal anteroposterior discrepancies are commonly associated with an increased ANB angle and may coexist with vertical imbalances. Their severity is assessed by comparing dentofacial features with individuals having normal occlusion and balanced facial relationships.

Numerous research efforts have focused on identifying the cephalometric characteristics of Class II skeletal malocclusion in certain population by examining lateral cephalometric x-rays.[11,12,13,14,15,16]

Studies on Class II Division 1 malocclusion report varying findings, including maxillary protrusion, mandibular retrusion, or a combination of both contributing to the skeletal discrepancy.[17]

Numerous research has explored the connection between cranial base structure and the development of Class II malocclusion.

To our knowledge, few studies have evaluated the positional and dimensional mandibular characteristics in the Lebanese population. Therefore, this study aimed to classify mandibular retrognathism in Lebanese Class II Division 1 skeletal malocclusion into positional and dimensional subtypes to support accurate diagnosis and treatment planning. The null hypothesis states that there are no statistically significant differences in mandibular size or position among individuals with Class II Division 1 malocclusion.

Materials and methods

This study was approved by the ethic committee of ‘000’. The sample size was calculated based on an assumed study power of 80% and a 95% confidence level. The calculated sample size was 120 lateral cephalograms. A total of 120 pretreatment lateral cephalometric radiographs of patients with skeletal Class II Division 1 malocclusion were collected from the outpatient records of the orthodontic department, ‘000’. The subjects’ selection was generally based on the following criteria:

1) ANB > 4 degrees

2) Mandibular retrognathism SNB < 78 degrees

3) Normal maxillary position as denoted by SNA 822

4) Age 18–30 years old

5) Lebanese heritage for three generations (participant and both parents of Lebanese origin)

6) Permanent dentition

7) No craniofacial disorders

8) No missing teeth

9) No history of orthodontic treatment

The sample was selected and grouped into two groups according to gender (60 females and 60 males). The cranial base angle and the total effective length of the cranial base were evaluated to determine mandibular position and the degree of retrusion. Mandibular dimensions were assessed using three linear measurements, the effective contribution of the mandible to the depth of the lower third (Ar-Pog/BaN), ratio of absolute length of ramus to cranial base (ArGo/BaN), and the ratio of absolute length of mandibular body to cranial base (GoPog/BaN). Gonial angle was measured to assess the mandibular morphology.

Cephalometric landmarks were traced (Fig. 1), six angular measurements were done (Fig. 2 Table 1). Four Linear measurements were then calculated (Fig. 3 Table 2) according to coben's linear coordinate system. [17] All cephalometric X-rays were retraced and remeasured after 1 month by the same operator in the same conditions.

Table 1
Angular measurement

SNA	**The position of the maxilla relative to the cranial base measured as an angle between SN plane and A-point (SNA).**
SNB	The position of the mandible to the cranial base measured as an angle between the SN plane and point B.
ANB	The position of the maxilla to the mandible at points A and B
Cranial base angle (N-S-Ba)	The angle between N S and Ba
Gonial angle (Ar-Go-Me)	The angle between Ar Go and Me
FMA	It is formed by the intersection of the Frankfort Horizontal Plane (Po-Or) and the Mandibular Plane (Go-Me).

Table 2
Linear measurements

Ba-N	**Total effective cranial base length**
	Measured as distance from the projection of Ba and N on the horizontal axis
Go-Pog	Linear distance from Go to Pog
Ar-Go	Linear distance from Ar to Go
Ar-Pog	Distance from the projection of points Ar and Pog on horizontal axis
Go-Pog/ BaN %	Ratio of absolute length of mandibular body to the cranial base length
	Ratio of Go-Pog to Ba-N*100
Ar-Go/ BaN %	Ratio of absolute length of ramus to cranial base length
	Ratio of Ar-Go to Ba-N*100
Ar-Pog/ BaN %	The effective contribution of the mandible to the depth of the lower third
	Ratio of Ar-Pog to Ba-N *100

Statistical Analysis:

All statistical procedures were performed using SPSS software (version 25.0; SPSS Inc., Chicago, IL, USA) on a Windows platform. Data distribution normality was evaluated using the Kolmogorov–Smirnov test. Variables of both groups were compared using independent *t*-tests with significance level set at *p*-value < 0.05.

Results

The sample exhibited an equal gender distribution, comprising 50% males and 50% females.Craniofacial divergence classifications indicated that 52.5% of participants fall within the normal range, while 32.5% are hyperdivergent and 15% are hypodivergent.

Table 3
Frequency and percentage distribution of measurements deviating from normal in males

Males with increased Cranial base angle	**Count**	**%**
	39	**65.00%**
Males with increased gonial angle	31	51.70%
Males with increased total effective cranial base length	60	100.00%
Males with decreased Ramal length	60	100.00%
Males with decreased Total effective mandibular length	54	90.00%
Males with decreased mandibular body length	60	100.00%

The results for males across various measurements indicate notable deviations from normal ranges. 65% of males scores larger value of cranial base angle. 51.7% scores high values of gonial angle. All males have increase in total effective cranial base length. As for ramal length and mandibular body length 100% of male scored below normal. For total mandibular effective length 90% scored below normal (Table 3).

Table 4
:Frequency and percentage distribution of measurements deviating from normal in females

Females with increased cranial base angle	**Count**	**%**
	30	**50.00%**
Females with increased gonial angle	13	21.70%
Females with decreased total effective cranial base length	60	100.00%
Females with decrease Ramal length	60	100.00%
Females with decreased total effective mandibular length	55	91.70%
Females with decreased mandibular body length	60	100.00%

The results for females across various measurements indicate notable deviations from normal ranges. 50% of females scores larger value of cranial base angle. 21.7% scores high values of gonial angle. All females have increase in total effective cranial base length. As for ramal length and mandibular body length 100% of females scored below normal. For total mandibular effective length 91.7% scored below normal (Table 4).

Table 5
Comparison of measurements between class II division 1 group and normal values for males and females

	Gender	N	Mean	Std. Deviation	Mean of normal range	P value
NSBa	Male	50	129.76	4.284	127	0
	Female	50	131.78	3.796	131	0.543
ArGoMe	Male	50	123.11	7.484	123.94	0.876
	Female	50	121.54	6.634	124.25	0
BaN	Male	50	99.9	3.464	92.8	0
	Female	50	98.04	4.102	90	0.003
ArGo/BaN%	Male	50	38.94	3.997	57.43	0.001
	Female	50	38.14	3.791	56.2	0
ArPog/BaN%	Male	50	70.2	4.306	92.89	0
	Female	50	71.51	4.148	96	0.002

The mean scores across several measurements for male and female participant was compared with reference to normal range values using independent T-test (Table 5). For cranial base angle (NSBa), males had a mean slightly above the normal range. Females had a mean of 131.78, close to the normal range, with no significant deviation. For gonial angle (ArGoMe), males showed no significant differences from normal range but females showed a significant deviation from the normal range. For total effective cranial base length, both males and females scored significantly higher than the normal ranges. For ramal length, males and females are both significantly below the normal range. Similarly, for total effective mandibular length and mandibular body length, both males and females show significantly lower scores compared to their normal ranges.

Table 6
Comparison of the measurements between females and males

	Gender	N	Mean	Std. Deviation	P value
NSBa	Male	50	129.76	4.284	0.007
	Female	50	131.78	3.796	
ArGoMe	Male	50	123.11	7.484	0.226
	Female	50	121.54	6.634	
BaN	Male	50	99.9	3.338	0.008
	Female	50	98.04	3.675	
ArGo/BaN	Male	50	38.94	3.997	0.262
	Female	50	38.14	3.791	
ArPog/BaN	Male	50	92.27	4.306	0.589
	Female	50	91.85	4.148	
GoPog/BaN	Male	60	66.67	3.040	0.202
	Female	60	67.37	2.927	

Comparison of male and female groups across several variables, with the mean and standard deviation provided for each group was done using independent t-test (Table 6). Gender differences were only significant for cranial base angle and total effective cranial base length, while for other measurements, there is no substantial gender effect.

Table 7
Pearson correlation analysis for the correlation between cranial base angle and mandibular dimensions

		NSBa	ArGo/BaN	ArPog/BaN	GoPog/BaN
NSBa	Pearson Correlation	1	-0.019	-0.051	-0.035
	Sig. (2-tailed)		0.841	0.577	0.706
	N	120	120	120	120
ArGo/BaN	Pearson Correlation	-0.019	1	.676**	.388**
	Sig. (2-tailed)	0.841		0	0
	N	120	120	120	120
ArPog/BaN	Pearson Correlation	-0.051	.676**	1	.753**
	Sig. (2-tailed)	0.577	0		0
	N	120	120	120	120
GoPog/BaN	Pearson Correlation	-0.035	.388**	.753**	1
	Sig. (2-tailed)	0.706	0.000	0.000	
	N	120	120	120	120

Pearson correlation analysis was done to assess correlation between cranial base angle (NSBa) and mandibular dimensions (Table 7).

The correlation analysis between cranial base angle and the three variables (ArGo/BaN, ArPog/BaN and GoPog/BaN) a showed no significant relationship. This suggests that the cranial base angle is not significantly associated with these variables.

Discussion

Class II Division 1 malocclusion is highly prevalent in the Lebanese population and may have skeletal, dental, or combined origins. Understanding its classification is essential for accurate diagnosis and effective orthodontic treatment. For this reason, the current study was conducted on a sample of the Lebanese population diagnosed with Class II Division 1 malocclusion at BAU. Lateral cephalometric measurements were taken for 120 patients, comprising 60 males, and 60 females.

The sample was divided by gender according to Lebanese normative values to allow accurate comparisons and assess potential gender differences in cephalometric measurements in Class II Division 1 malocclusion.

The Coben coordinate system was applied to analyze the lateral cephalograms. This approach offers the advantage of expressing facial structures in proportional terms, thereby enhancing the understanding of the multiple factors involved in the development of Class II malocclusion.[17]

Using proportions of mandibular measurements relative to cranial base length provides more accurate data than absolute measurements, as variations in absolute values may bias result interpretation.

In the current study, cranial base angle and total effective cranial base length were measured to assess mandibular retrusion and position. Mandibular dimensions were assessed using three linear measurements, the effective contribution of the mandible to the depth of the lower third (Ar-Pog/BaN), ratio of absolute length of ramus to cranial base (ArGo/BaN), and the ratio of absolute length of mandibular body to cranial base (GoPog/BaN). Gonial angle was measured to assess the mandibular morphology.

Cranial base morphology is an important etiological factor in Class II malocclusion. In this study, males showed significantly increased cranial base angles, while females had values closer to normal, with females exhibiting slightly higher angles than males.

Total effective cranial length (Ba–N) was significantly greater than normal in both males and females, with males showing higher mean values than females. 65% of the males and 50% of the females exhibited an increased cranial base angle, while 100% of the sample demonstrated an increase in total effective cranial base length. These findings might imply differences in cranial base morphology potentially influencing the mandibular position in Class II division 1 malocclusion where the glenoid fossa will be consequently positioned backward leading to the mandible being set back.

Class II malocclusion had been proven in many studies to exhibit a larger cranial base angle. This increased flexure in the cranial base positions the mandible posteriorly, contributing to the development of Class II malocclusion.**[18]** The results obtained in the current study align with numerous studies.

Dhopatkar et al.[19] reported that the cranial base angle was significantly greater in the Class II Division 1 group. Similarly, Chin et al.[20] concluded that individuals with Class II malocclusion exhibit an increased cranial base angle along with a longer cranial base length compared to those with Class I malocclusion.

The cranial base angle (NSBa) was found to be significantly greater in individuals with Class II malocclusion compared to those with Class I and Class III patterns. In contrast, the posterior cranial base length (NBa) was slightly reduced in the Class II group relative to the other classes.[21]

In a similar context, El Haj et al.[17] examined a skeletal Class II cohort to determine the respective roles of the maxilla and mandible in the development of Class II malocclusion among Lebanese adults. Their results demonstrated increased total effective cranial base depth as well as an enlarged anterior cranial base angle (SN–BaH) in the Class II group.

Conversely, Kasai et al.[22] observed no statistically significant differences in cranial base length or angulation between Class I and Class II groups. Likewise, Wilhelm et al.[23] reported that the cranial base angle remained statistically comparable between these classifications across all age groups studied.

The gonial angle seems to have no influence on the development of class II division 1 as there was no tendency towards an increase in gonial angle neither in males nor in females. There was actually a significantly smaller than normal gonial angle in females rather than in males. Similarly, Hashim et al.[24] found that class II individuals had a mean gonial angle that was not significantly different than class I individuals.

Al-Khateeb et al.[14] reported no statistically significant sex-related differences in gonial angle measurements. However, they noted that the gonial angle was more obtuse in Class II Division 1 cases compared with Class II Division 2 and Class I groups. This enlargement was linked to a steeper mandibular plane and a predominantly vertical growth pattern, these findings were inconsistent with those of the present study.

Both males and females showed significantly reduced mandibular, ramal, and body lengths relative to cranial base length. All patients had reduced ramal and body lengths, while 90.8% showed decreased total mandibular length which was consistent with previous studies.

Yassir [25] found decreased ramus length, total mandibular length and body length in class II subjects compared to class I. In his study, males had significantly larger values than females in the three dimensions. Perillo et al.[26] evaluated the dentoskeletal features of Class II Division 1 malocclusion with mandibular retrusion and found that reduced mandibular length was the most prevalent characteristic, observed in 80.3% of the patients.

In contrast, Dhopatkar et al.[19] reported that mandibular length measurements (Cd–Pog, Art–Pog, and Me–Go), representing overall mandibular dimensions, were comparable between Class I and Class II subjects, while being significantly greater in individuals with Class III malocclusion.

The results of Raja et al.[21] agreed that the total mandibular length measured as (Co-Pog) was significantly shorter in Class II individuals compared to Class I and Class III. The mandibular body length (Go-Me) was also shorter in Class II individuals compared to Class III and slightly shorter than Class I.

Co-Gn length was shorter in Class II malocclusions compared to Class I and Class III groups.[27] On the same note, Ardani et al.[28] found that class II individuals showed significantly shorter mandibular lengths compared to Class I and III malocclusions.

Likewise, individuals with a Class II skeletal pattern exhibited reduced ramus height, while those with a Class III relationship showed an increased mandibular body length compared to the Class II group.[24]

All three dimensions of the mandible had no significant difference between male and female. On the contrary, Ayoub et al.[29] found out male have significantly larger total mandibular length and base length compared to females when measuring Me-Go evaluating the length of the mandibular corpus and Co-Gn evaluating the total mandibular length where both were larger in male group. These differences can be justified that males generally have larger skeletal linear dimensions due to biological and anatomical variations

Vertical dimension plays an important role in Class II Division 1 malocclusion and mandibular position. The hyperdivergent group (32.5%) showed increased vertical facial growth and backward mandibular rotation.

This finding agreed with several studies. Al-Khateeb[14] found that the mean maxillo-mandibular angle (MM) was higher in class II division 1 group indicating vertical growth pattern.

Although cranial base variations contributed to Class II Division 1 malocclusion, the mandible was reduced in all dimensions, supporting early functional appliance therapy to enhance mandibular growth.[30]

Conclusion

All participants showed reduced ramal/body length and increased cranial base length; mandibular length was reduced in 90% of the sample with no gender difference, and gonial angle had little role.

Declarations

Ethics approval and consent to participate This study was approved by the ethic committee of Beirut Arab University faculty of dentistry. IRB pre-approval Number 2024-H-0144-D-M-0592 to the following title: “Positional and Dimensional Characteristics of the mandible In Lebanese Class II Division 1 Skeletal Malocclusion Patients (cross-sectional study)”

The study protocol was reviewed and approved by the Institutional Review Board (IRB) of Beirut Arab University (Approval No. 2024-H-0144-D-M-0592). In accordance, the requirement for informed consent to participate was waived because the study involved retrospective analysis of anonymized data and posed minimal risk to participants.

All procedures performed in this study involving human participants were conducted in accordance with the ethical standards of the Institutional Review Board (IRB) of Beirut Arab University and with the principles of the **Declaration of Helsinki and its subsequent amendments**, as well as relevant national regulations and guidelines.

Human Ethics and Consent to Participate declarations: Not applicable

Consent for publication Not applicable.

Competing interests The authors declare no competing interests.

Data availability

All the data generated or analyzed during this study are included in this article. Further inquiries can be directed to the corresponding author.

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Author contributions

All authors contributed to the study conception and design. All authors read and approved the final manuscript. AD,AO,NH: Conceptualization, Methodology, Data curation, Writing- Original draft preparation, Visualization, Investigation. AD,AO,NH: Supervision, conceptualization, validation, reviewing. AO,NH: Supervision, conceptualization, validation, reviewing and editing.

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Figures

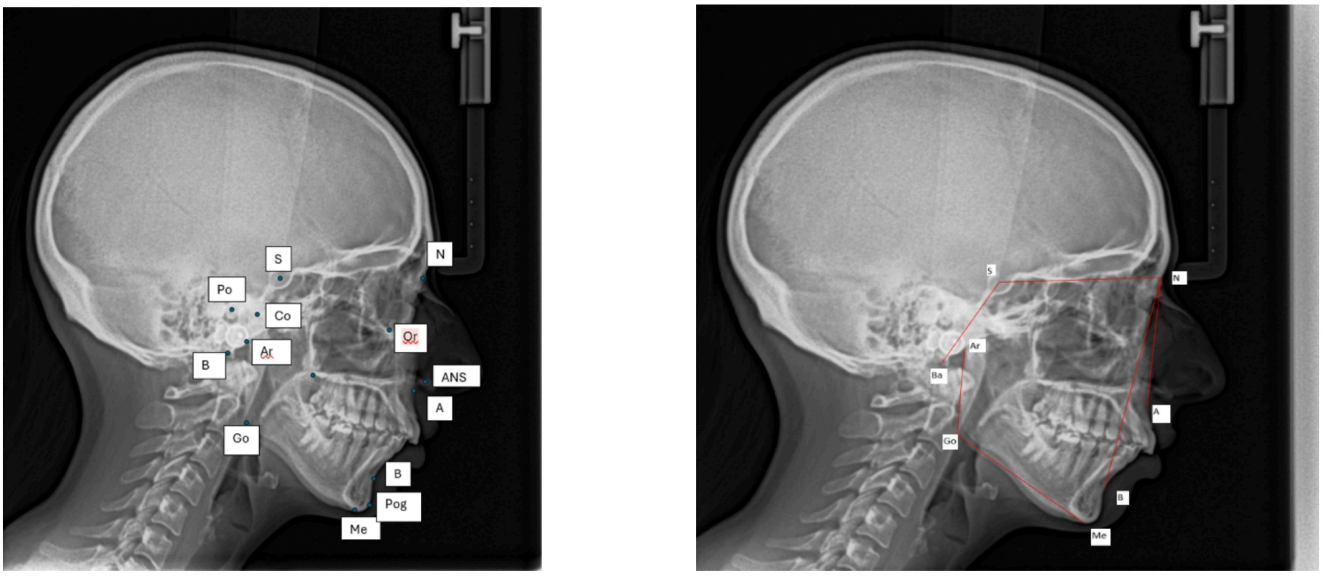


Figure 1

Hard tissue cephalometric landmarks

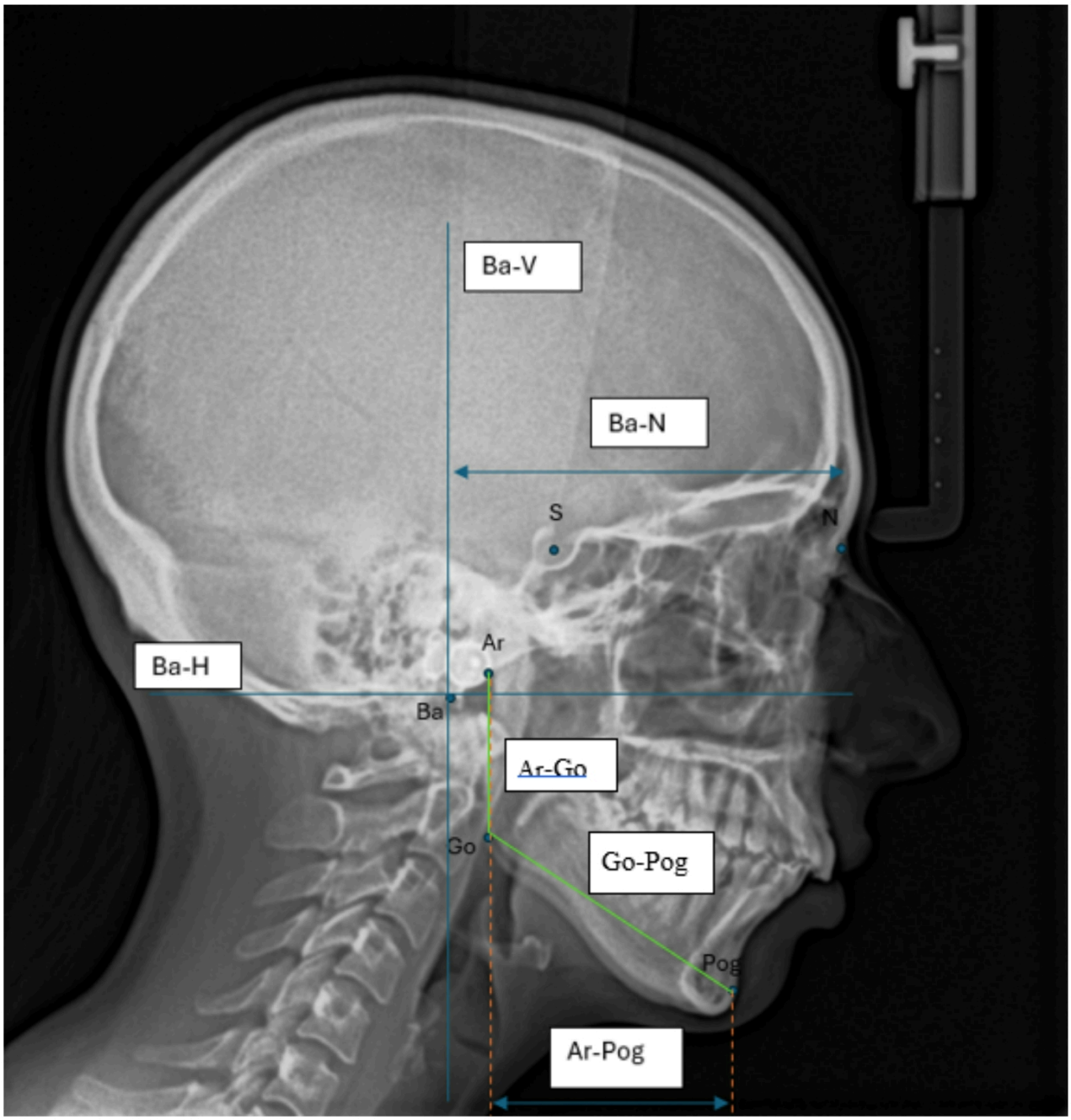


Figure 2

Angular measurements