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Original Article

Anatomy Section

A Cross-sectional Study on Gonial Angle Variations by Age and Gender in Tertiary Care Centre, Lucknow, Uttar Pradesh, India

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ABSTRACT

Introduction: The mandibular angle, also known as the gonial angle, is the posterior-most point of the mandible where the ramus and body meet. This angle is crucial in forensic science for identifying gender and age.

Aim: To determine whether gonial angle is related to gender and age.

Materials and Methods: A cross-sectional study using 68 lateral cephalograms from participants aged 11-40 was conducted in the Department of Anatomy in collaboration with the Department of Dentistry at Era's Medical College and Hospital, Lucknow, Uttar Pradesh, India. Gonial angle measurements were obtained using a digital protractor. Lateral cephalograms of participants with jaw fractures, acquired skeletal deformity, and postsurgical cases were excluded from the study. To analyse the variation in gonial angle across different age groups, participants were categorised into three groups: 11-20, 21-30, and 31-40. Statistical analysis was performed using ANOVA to compare the gonial angles among the different age groups.

Results: The gonial angle in males was recorded with a mean value of 119.757 and standard deviation of 7.6131, while for females the mean value was recorded as 118.811 with a standard deviation of 5.9614. The mean value of the gonial angle in the age group of 11-20 was 119.734° for males, while for females it was 119.487°. In the age group 21-30 the mean value of gonial angle in male was 113.5° while in females it was 115.112°. There were no male participants in the age group 31-40, however the mean value of gonial angle in females was 122.8°.

Conclusion: The current study's results indicate that gonial angle varies across different age groups, particularly showing a discernible difference between the ages of 21-30 and 31-40, which can be utilised to determine an individual's age. No statistically significant difference in gonial angle was found across genders.

Keywords: Cephalometry, Demography, Mandible

INTRODUCTION

The mandible is an important bone in forensic medicine and anthropology for determining gender, age, and growth pattern prediction. Numerous studies have been published in the literature that interrelate age, gender, dental health with gonial angle on the mandible [1,2].

Anatomical landmarks such as gonial angle, height of the mandibular ramus, bigonial breadth, and the antegonial angle and its depth are frequently used to estimate gender. The gonial angle is important for cephalometric analysis because it provides a useful reference point for predicting the mandibular growth pattern and rotation. Mandibular growth patterns are often characterised by growth at the condyles, which curves upward and forward, along with some apposition below the symphysis and resorption on the lower part of the gonial angle [3]. In cases of hyperdivergent or high angle individuals, the mandible rotates downward and backward, suggesting an elevated gonial angle (obtuse). On the other hand, gonial angle values in hypodivergent or low angle individuals usually tend to be decreased (i.e., acute) [1,4,5]. The main goal of cephalometric analysis is to assess the horizontal and vertical relationships between the five main functional and aesthetic components of the face- the cranium and cranial base, the skeletal mandible, the skeletal maxilla, the maxillary dentition and alveolar process, and the mandibular dentition and alveolar process [6]. When designing an approach for treatment and determining its success, it is crucial to consider the vertical and horizontal angulations, measurements and relationships for achieving a harmonious and functional occlusion [7]. Previous studies have shown that the gonial angle is a significant parameter in orthodontics and forensic science, influencing craniofacial morphology and being indicative of age and sex [1,8,9]. However, there is a lack of comprehensive data, especially from diverse populations.

There is a need for integrating the gonial angle with other craniofacial characteristics to provide a holistic view of mandibular growth and development and translating cephalometric findings into practical clinical applications for orthodontic treatment and surgical planning. The study was conducted with an aim to find the association of gonial angle with age and gender.

MATERIALS AND METHODS

This cross-sectional study was done from Jan-June 2023 in the Department of Anatomy in collaboration with the Department of Dentistry at Era's Medical College and Hospital, Lucknow, Uttar Pradesh, India, involving 68 participants. Ethical clearance was obtained from the appropriate committee with reference number ECR/717/INS/UP/2015/RR-21 and all participants provided informed consent.

Sample size calculation: The sample size of 68 was determined based on prior treatment lateral cephalograms available in the department records between Jan-June 2023. This sample size was selected to ensure a sufficient representation across different age groups for statistical analysis.

Participants: The study included 68 participants, aged 11-40 years, categorised into the following age groups: 11-20 years, 21-30 years, and 31-40 years. Notably, there were no male participants in the 31-40 years age group.

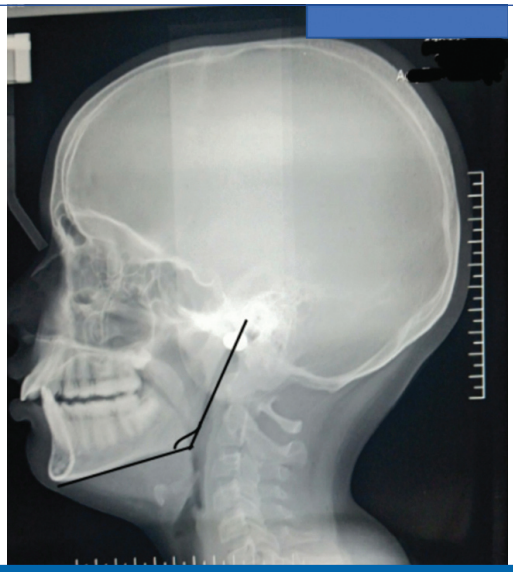
Inclusion criteria: Lateral cephalograms of participants with attrition, with traumatic bite, malocclusion, bruxism.

Exclusion criteria: Lateral cephalograms of participants with jaw fractures, acquired skeletal deformities and postsurgical cases.

Methodology [9]

The ruler tool in photoshop was used to draw a line along the lower border of the mandible.

1. The canvas was rotated (image >rotate canvas >arbitrary) to make this line horizontal.
2. Rulers were enabled (Ctrl+R on Windows, Cmd+R on Mac), and a guide was dragged to the lower border of the mandible.
3. Another line was drawn along the posterior border of the ramus using the ruler tool.
4. The angle displayed between these lines was noted as the gonial angle. If negative, it was subtracted from 180 degrees to get the true angle.
5. At least three readings per case were taken to reduce the variability and increasing the consistency of the result.
6. Parameters Studied: Gonial angle [Table/Fig-1], age and gender.



[Table/Fig-1]: Digital lateral cephalogram showing the gonial angle.

STATISTICAL ANALYSIS

Descriptive statistics were used to summarise the data. Discrete data were presented as proportions and percentages. Comparisons among various age and gender groups were made to investigate the relationship between gonial angle, age, and gender.

RESULTS

A large majority of the sample (80.89%) is from the 11-20 years age group. This dominance may skew the results towards the characteristics of younger individuals. There is a notable gender imbalance, particularly in the 31-40 years age group [Table/Fig-2].

Age group	% Female	% Male	% Total
11-20 years	32 (76.2%)	23 (88.47%)	55 (80.89%)
21-30 years	8 (19.04%)	3 (11.53%)	11 (16.17%)
31-40 years	2 (4.76%)	0	2 (2.94%)
Total	42 (100%)	26 (100%)	68 (100%)

[Table/Fig-2]: Age group distribution, statistical test used ANOVA.

The mean gonial angle for males was 119.757° and therefore was slightly higher than for a female which was 118.811°. The p-value of 0.55 indicates that there was no significant change across gender. Females showed a higher maximum (137.2°) and lower minimum (108.5°) as compared to males [Table/Fig-3].

There is a trend of decreasing gonial angle with increasing age in both males and females. However, the lack of male data in the 31-40 years group limits a complete understanding. The standard deviation is generally lower in females across all age groups, indicating less variability in their gonial angles compared to males [Table/Fig-4].

Gender	No. of participants	Max angle	Min angle	Mean angle and SD	p-value
Male	26	135.3°	110.9°	119.757°9 (7.6131)	0.55
Female	42	137.2°	108.5°	118.811° (5.9614)	

[Table/Fig-3]: Gonial angle comparison between genders, statistical test used "t test".

Age group	Gender	Max angle	Min angle	Mean angle and SD
11-20 years	Male	135.3°	110.9°	119.734° (7.357)
	Female	135.2°	108.5°	119.487° (6.118)
21-30 years	Male	132.8°	111.3°	113.500° (5.692)
	Female	118.5°	109.2°	115.112° (3.089)
31-40 years	Female	125°	116.5°	122.800° (4.645)
	Male	-	-	-

[Table/Fig-4]: Gonial angle analysis by age groups and gender, statistical test used ANOVA.

Interpretation

- **Gender effect:** The F value for sex is 0.358 with a p-value of 0.5519, indicating no statistically significant difference in gonial angles between males and females.
- **Age group effect:** The F value for age group is 4.186 with a p-value of 0.0196, indicating a statistically significant difference in gonial angles across different age groups.
- **Residuals:** The high sum of squares and mean square for residuals suggest considerable variability within the groups [Table/Fig-5].

Source	df	Sum Sq.	Mean Sq.	F-value	Pr (>F)
Gender	1	14.4	14.36	0.358	0.5519
Age group	2	336.2	168.09	4.186	0.0196
Residuals	64	2569.9	40.15	-	-

[Table/Fig-5]: ANOVA analysis.

Interpretation

- **Significant differences:** The only significant difference is between the 31-40 years and 21-30 years age groups (p=0.024). The difference of 11.217° suggests a notable change in gonial angle with age.
- **Non-significant differences:** The other comparisons (21-30 vs. 11-20 years and 31-40 vs. 11-20 years) are not statistically significant, indicating that these age groups have similar gonial angles [Table/Fig-6].

Comparison	Difference	Lower	Upper	p-value
21-30 vs. 11-20	-4.595°	-9.822°	0.632°	0.096
31-40 vs. 11-20	6.623°	-2.392°	15.637°	0.194
31-40 vs. 21-30	11.217°	1.208°	21.226°	0.024

[Table/Fig-6]: Pairwise comparison.

Overall Interpretation

The statistical analysis reveals that age has a significant impact on gonial angle, with notable differences observed particularly between the 31-40 years and 21-30 years age groups. Gender does not significantly affect gonial angles.

DISCUSSION

Relationship between Gonial Angle and Gender

In the present study, a comparison of gonial angles between males and females was conducted. The range of gonial angles in males was 135.3° to 110.9°, with a mean value of 119.757° and a standard deviation of 7.6131. In females, the gonial angle ranged from 137.2° to 108.5°, with a mean value of 118.811° and a standard deviation of 5.9614.These findings align with the research by Raustia AM and

Salonen MA which indicated no statistically significant difference in the gonial angle across gender [6]. A study by Ohm E et al., and in a research by Chole RH et al., the relationship between gender and gonial angle, antegonial angle, and antegonial depth was significant [10,11]. Dutra V et al., found no discernible variation in gonial angles between sexes [12]. However, Jensen E et al., observed that the mean gonial angle in females was 3-5 degrees higher than in males across all racial groups [13]. Huumonen S et al., also reported that compared to men, women had smaller ramus and condylar heights as well as a substantially larger gonial angle [14]. Shreshtha R et al., and Al-Shamount R et al., found increased gonial angles in females, though the increase was not absolute in Al-Shamount's study [15,16]. Additionally, Meleveetil DB et al., in their study showed a statistically significant difference in the mean gonial angles between males (159.19 mm) and females (156.33 mm) [17].

Relationship between Gonial Angle and Age

Regarding the relationship between gonial angle and age, our study found the following results for different age groups. Males aged 10-20 years had a gonial angle range of 135.3°-110.9°, with a mean of 119.734° and a standard deviation of 7.357. Females in the same age group had a range of 135.2°-108.5°, with a mean of 119.487° and a standard deviation of 6.118. For the age group 21-30 years, males had a gonial angle range of 132.8°-111.3°, with a mean of 113.500° and a standard deviation of 5.692, whereas females ranged from 118.5°-109.2°, with a mean of 115.112° and a standard deviation of 3.089. There were no male participants in the 31-40 years age group, but females ranged from 125°-116.5°, with a mean value of 122.80° and a standard deviation of 4.645.

Our findings correspond with Shah PH et al., who discovered statistically significant age-related changes in gonial angle dimensions, although ramus height and bigonial width did not correlate significantly with age [18]. Larrazabal-Moron C and Sanchis-Gimeno JA reported a substantial negative correlation between age and gonial angle, contrasting with Fattah AH et al., who noted an increase in gonial angle with age [3,19]. Bhuyan R et al., found that as men aged, their gonial angle rose on the left-side, while there was no significant link on the right-side for men or on either side for women [20]. Additionally, Abu-Taleb NS et al., found a statistically significant positive correlation between age and mandibular ramus [21]. Upadhyay RB et al., found a definite increase in the gonial angle with advancing age [22].

Advantages of Digital Method in Lateral Cephalograms for Measuring Gonial Angle

In the present study, we have incorporated the use of digital methods in lateral cephalograms for measuring the gonial angle which provides a significant enhancement in both accuracy and reliability. The digital method allows for consistent and repeatable measurements, reducing variability and improving the reliability of the results. The study by Girdhar A et al., have shown that digital methods offer higher accuracy in estimating gender compared to manual methods [23].

Type of Radiograph for Gonial Angle Measurements

Many studies have been conducted to evaluate mandibular parameters such as gonial angle, measured from panoramic radiographs also, to establish a correlation with an individual's age and gender. The study by Levarsha J et al., revealed results where females had significantly larger gonial angles as compared to males ($p< 0.0002$) and a trend revealed gonial angle to increase with age [24]. Rehman SA et al., also conducted his study on panoramic radiographs and found that the average gonial angle in males was 124.10°±5.67° and in females was 125.59°±7.99° [25]. Pillai J P et al., found a significant difference in the gonial between lateral cephalograms and panoramic radiographs [26]. In his study, a significant gender difference in gonial angle was observed in lateral cephalograms.

In summary, our study's findings on the relationship between gonial angle and gender, as well as age, show some similarities and differences compared to existing literature. While some studies [6,12] agree with our findings on the lack of significant gender differences in gonial angles, others report a higher mean angle in females. Similarly, age-related changes in gonial angles vary, with some studies [3,19] indicating an increase and others a decrease or no significant change, aligning with our observations in different age groups.

Future studies should aim for a more balanced and larger sample to validate these findings.

Limitation(s)

The differences in means between age groups suggest age-related morphological changes, but the sample sizes are too small for a robust conclusion.

The results lack generalisability however it definitely shows certain trends which can be used for further research in craniofacial disorders.

CONCLUSION(S)

Gaining an in-depth understanding of the gonial angle's normal architecture and its variations is crucial, as these details play a critical role in surgical procedures and orthodontic therapy. The results of this study indicate that the gonial angle is not significant across gender but significantly associated with different age groups, highlighting a discernible difference between the ages of 21-30 and 31-40. These findings suggest that the gonial angle can be a valuable parameter for estimating an individual's age, thereby enhancing its utility in clinical settings for both diagnostic and treatment planning purposes. This study bridges the gap in literature by translating cephalometric findings into practical applications, ultimately contributing to improved orthodontic and surgical outcomes.

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