Original Research Article

Combined Effect of Age and Sex on the Gonial Angle of Mandible in North-Indian Population

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Abstract

The gonial angle of mandible, commonly known as the mandibular angle contributes significantly to the cosmetic facial profile of a person. The present study was conducted to examine the combined effect of age and sex on the Gonial Angle (GA) of the mandible in a group of North-Indian population. For this purpose, 60 adult human orthopantomographs (dental panoramic radiographs), ranging from 35-65 years were selected and divided into six groups of five-year age interval each with equal number of males and females. These digitalized radiographs were printed on special photographic papers. Gonial angle was measured as the angle formed between the inferior mandibular border and the posterior ramus, using a protractor. The mean of right-sided and left-sided values of gonial angle was calculated for each radiograph. These measurements were analyzed for interactions with age and sex, using SPSS software (version no. 18). In males, the mean gonial angle values ranged from 114.8° ± 8.341° to 122.3° ± 8.722°. In females, the values ranged from 114.7° ± 5.227° to 122.65° ± 5.413°. Significant positive correlations ($p<0.05$) were calculated between age and gonial angle for both males ($r=0.386$) and females ($r=0.403$), as the mean gonial angle values showed an increase with increasing age in both the sexes. The female values recorded were higher than those of males in majority of the age groups. But sexual dimorphism was not observed. Therefore, the results of the present study concluded that age had a significant influence on the gonial angle but sex affected the gonial angle only to a certain extent.

Keywords: Panoramic radiography, mandible, bone remodelling, age factors, sex characteristics

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Introduction

The mandible bone which forms the lower jaw plays an indispensible role in determining an individual's facial features. It undergoes constant remodelling and morphological alterations throughout the lifetime of a person. The influence of aging on the remodelling changes of the mandible has been shown by longitudinal studies (1). The effect of sex or gender on the various regions of the mandible i.e. the ramus, condyle, body, etc. has also been documented (2,3). Panoramic X-Ray technology, which is easily accessible nowadays, is commonly used in dental clinics to assess the vital mandibular structures (4). A variety of mandibular indices based on panoramic radiographs or orthopantomographs have been developed in the recent past by many authors across the globe for both the quantitative and qualitative estimation of the mandible bone. Since, these radiographs allow a bilateral view, the assessment of remodeling changes of the mandible through the indices turns out to be very systematic and informative at the same time.

Gonial angle/mandibular angle is an angular radiomorphometric index of the mandible. It is the angle of jaw i.e. the angle formed between the inferior mandibular border and the posterior border of the

mandibular. The term "Gonion" is derived from the word "ywvtx" which stands for 'angle' in greek language. The cosmetic profile of an individual is indelibly affected by the status of the gonial angle as its widening can cause the face to appear older (5,6). The gonial angle, which forms an integral part of the structural anatomy of the base of mandible, is greatly influenced by the integrity and functional status of the muscles of mastication, especially the masseter and medial pterygoid because they are inserted into this region (7). The documentation of the influence of age and gender related variations on the gonial angle size is controversial as contradicting results have been reported in literature. Previous studies have shown the existence of smaller gonial angle size with increased functional status of the masseter and anterior temporal muscles, on electromyographic tests (8). Hence, it is implied that larger gonial angles would be associated with increasing age, owing to the senile effects of decreasing muscle mass and reduction in muscle power. While few studies agree with this facts (9,10); others have reported different results (11,12,13). The effect of an individual's sex on gonial angle has also been reported, with majority of the authors reporting the female gender to possess wider angles when compared to the males (12,13,14). However, the results of few authors were different (9,11).

Considering the importance of gonial angle in maintenance of facial aesthetics, the evalution of the effects of age and sex on this index of the mandible is highly beneficial. Therefore, the present study was conducted with the aim of measuring the gonial angle in a group of North- Indian population of Haryana (a state of India) and to study the influence of age and sex on the gonial angle.

Materials and Methods

The Study Sample and Design

The present study was conducted in the department of Anatomy, Pt. B. D. Sharma Post Graduate Institute of Medical Sciences, Rohtak (Haryana, India) in collaboration with the department of Periodontology using 60 adult dental panoramic radiographs i.e. orthopantomographs, 30 males and 30 females. These orthopantomographs ranging from 35 to 65 years of age, belonged to routine patients visiting dental clinics for various indications like periodontal diseases, implantations, cosmetic treatment etc. The radiographic machine used was Kodak 8000 (Kodak Eastman Company, France). Name, C.R. No., age and sex of the patients were recorded for each radiograph from the records of the radiography department. The following radiographs were excluded from the study:

1. Poor quality images.
2. Radiographs with distorted images of the mandible.
3. Radiographs in which the gonion points of both sides were not clearly visible.
4. Radiographs where either the gonial angles of both sides were not visualized completely.
5. Radiographs in which the inferior border of the mandible, posterior border of the ramus or the condyle were not readable to allow proper measurements of the angle on both sides.
6. Radiographs which showed any obvious gross distortion of the normal anatomical landmarks, for example, presence of a cyst, destructive lesions of mandible- which interfere with measurements.

The entire sample size of 60 orthopantomographs was divided into six age-groups of five-year age interval each as follows: group 1: 35-40 years, group 2: 41-45 years, group 3: 46-50 years, group 4: 51-55 years, group 5: 56-60 years, group 6: 61-65 years. Ten radiographs were used for each group with equal distribution of males and females.

Radiographic Measurements

The digitalized radiographs were printed on special photographic papers. Two lines were drawn; one drawn tangent to the inferior border of mandible and the other drawn tangent to the posterior border of the mandibular ramus. The Gonial Angle/GA was measured as the angle formed between these two lines, using a protractor.

GA was measured bilaterally on all radiographs and the mean of right-sided and left-sided measurements was calculated for every radiograph.

Statistical Analysis

Comparisons of the mean GA values were made between different age groups and also between both sexes. The data obtained from comparisons was subjected to statistical analysis using SPSS (Statistical package for social studies) software version no. 18. Mann-Whitney tests were used for inter- and intra-age-group comparisons. Unpaired T-Test was used to ascertain the presence of sexual dimorphism.

Results

The range of gonial angle values recorded for males in the present study was shown in Table 1. In males, the mean gonial angle values ranged from $114.8^{o} \pm 8.341$ to $122.3^{o} \pm 8.722$. There was a uniform trend of

increase in values of mean gonial angle with increase in age in males (Fig.2). The highest mean gonial angle value in males was reported in group 6 (61-65 years) while the lowest mean gonial angle was reported in group 1 (35-40 years).

The range of gonial angle values recorded for females in the present study was shown in Table No.1. In females, the mean gonial angle values ranged from 114.7º ± 5.227 to 122.65º ± 5.413. There was an increase in trend of mean gonial angle values with increase in age from group 2 to group 6 (Fig. 2). However, group 1 (35-40 years) did not conform to this trend as the mean gonial angle value observed for this group was more than those of groups 1 and 2. Hence, this trend was not uniform, in contrast to the observation made in males. The highest mean gonial angle value in females was observed in group 6 (61-65 years) whereas lowest mean gonial angle value in females came from group 2 (41-45 years).

Significant positive correlations ($p<0.05$) between age and mean gonial angle were recorded for both males and females (Fig. 3). Value of the correlation coefficient was greater in females than in males.

However, the inter-age-group comparisons showed statistically insignificant differences for both males and females when the mean gonial angle values were compared separately for successive age groups, in both the sexes (Table 2).

Mean gonial angle values were found to be higher in females when compared to males in all age groups except for group 2 (41-45 years) where the female mean gonial angle value was less than that of males (Fig.2, Table No. 3). However, all these differences were found to be statistically insignificant ($p>0.05$) (Table 3).

Even though the overall female mean GA value was greater than its male counterpart (Fig. 4), this difference was calculated as statistically insignificant ($p>0.05$) by the unpaired T- test. Hence, no sexual dimorphism was observed.

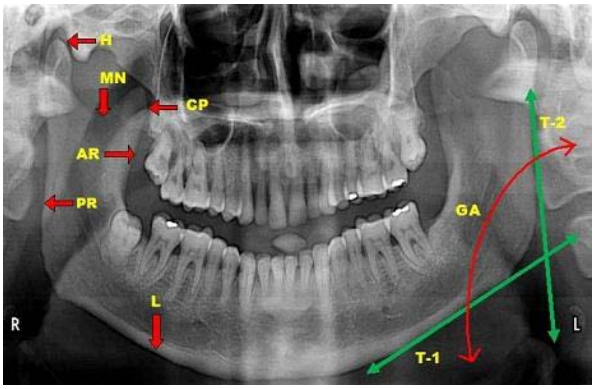

Figure 1: Orthopantomograph used in the study showing various anatomical landmarks of the mandible (on left side): L-Inferior border of mandible, PR-Posterior border of ramus, GA-Gonial angle/ mandibular angle, H-Head of mandible, AR-Anterior border of ramus, MN-Mandibular Notch, CP-Coronoid Process. The method of measuring Gonial Angle (GA) (Depicted on left side): T1 – Line tangent to the lower border of the mandible. T2 – Line tangent to the posterior border of ramus of the mandible. GA or Gonial Angle- The angle formed between T1 and T2.

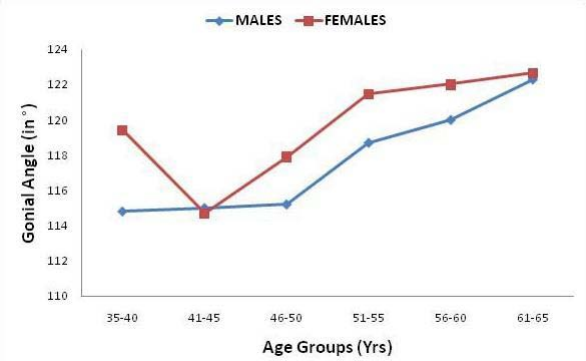

Figure 2: Graph depicting the trend of Gonial Angle (GA) with increasing age in males and females.

Table 1: Gonial Angle (GA) values (in °) in males and females in different age-groups

Group	Age (Years)	Males		Females	
		Range (In °)	Mean GA (In °) ±S.D.	Range (In °)	Mean GA (In °) ± S.D.
1	35 - 40	108.5 - 127	114.8 ± 8.341	113.5 - 122.5	119.4 ± 3.782
2	41 - 45	111.5 - 121	115 ± 3.889	110.5 - 123.5	114.7 ± 5.227
3	46 - 50	109.5 - 124.5	115.2 ± 5.696	116 - 122	117.9 ± 2.382
4	51 - 55	110 - 131	118.7 ± 11.015	113.5 - 128.5	121.45 ± 6.17
5	56 - 60	106 - 125.5	120 ± 8.047	117 - 126	122 ± 3.536
6	61 - 65	114 - 131.5	122.3 ± 8.722	118.5 - 131.5	122.65 ± 5.413

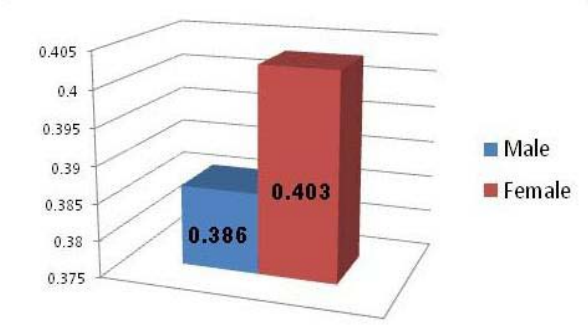

Figure 3: Pearson's Correlation Coefficient (r value) between age and mean gonial angle in males and females.

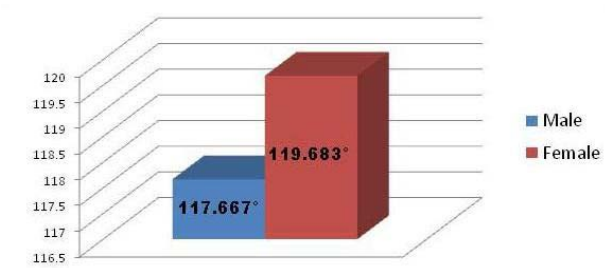

Figure 4: Comparison of mean gonial angle between males and females.

Discussion

The observations made in the present study implied that a strong association existed between gonial angle size and age, but the effect of sex on the gonial angle was relatively limited. A comparative study of the results of our study with those of various other authors is presented in Table 4 (A,B,C).

A significant positive correlation was observed between gonial angle and age in both sexes in our study, same as that observed by Ohm and Silness (9) in Norwegian population. A trend of increase in mean gonial angle values with increasing age was seen in both sexes, similar to that seen by Ohm and Silness (9) and Shamout et al. (15) in Jordanian population (as shown in Table 4A and 4B). The explanation for this trend is the combined effect of senile alterations in the morphology of the basal bone of mandible and the reduced density and activity of masticatory muscles due to aging. With advance in age, the mandibular process and reinforcing bone are weakened by the osteoclastic activity which results in the formation of a silhouette, very similar to the process of development and growth of the mandibular condyle seen in the initial years of life. Due to this remodelling, the angle again opens out as in childhood. Also, the decreasing contractile power of masticatory muscles inserting in the mandibular angle region (masseter and medial pterygoid) has a widening effect on the gonial angle

Table 2: Comparison of the mean Gonial Angle (in °)

Age groups compared		Males	Females
Group No.	Age (years)		
1 & 2	35-40 & 41-45	p > 0.05	p > 0.05
2 & 3	41-45 & 46-50	p > 0.05	p > 0.05
3 & 4	46-50 & 51-55	p > 0.05	p > 0.05
4 & 5	51-55 & 56-60	p > 0.05	p > 0.05
5 & 6	56-60 & 61-65	p > 0.05	p > 0.05
1 & 6	35-40 & 61-65	p > 0.05	p > 0.05

between different age groups (Mann-Whitney Tests)

Table 3: Age-wise comparison between male and female mean Gonial Angle (GA values (in °) (Mann-Whitney Tests)

Group No.	Age (Yrs)	Mean Male GA (°) ± SD	Mean Female GA (°) ± SD	p-value
1	35-40	114.8 ± 8.341	119.4 ± 3.782	p > 0.05
2	41-45	115 ± 3.889	114.7 ± 5.227	p > 0.05
3	46-50	115.2 ± 5.696	117.9 ± 2.382	p > 0.05
4	51-55	118.7 ± 11.015	121.45 ± 6.17	p > 0.05
5	56-60	120 ± 8.047	122 ± 3.536	p > 0.05
6	61-65	122.3 ± 8.722	122.65 ± 5.413	p > 0.05

(16,17,18). The only exception in females was for group 1 which showed higher values than those of groups 2 and 3. Unusual high values in the younger age-group (35-40 years) in females recorded in the study is partly supported by the results of Dutra et al. (19) in British population and Israel (20) in American population, both of whom reported that the values of gonial angle remained constant with age. The only explanation offered by these authors was that according to their respective studies, the gonial angle had no correlation with the bone mineral status of an individual.

The male mean gonial angle values of present study were similar to the ones recorded by Xie and Ainamo (13) in Finnish population. Whereas, higher values have been observed by Shamout et al. (15) and Ohm and Silness (9) (as shown in Table 4A). Female mean gonial angle values of our study were closest to those recorded by Xie and Ainamo (13) but were lower than those presented by Shamout et al. (15) and Ohm and Silness (9) (as shown in Table 4B). These variations in the values of gonial angle reported by different authors are attributed mainly to the racial or ethnic differences which exist in various populations of the world for any

Table 4A: Comparison of the results of the present study with previous studies – I

Author	Population	Age-group (years)	Males		
			Range of Mean Gonial Angle (°)	Correlation between Gonial Angle and Age	Inter age-group comparisons
Casey et al.	American	-	-	-	-
Ohm et al.	Norwegian	18-86	122.3° ± 7.3 to 126.6° ± 7.2	Increase with age, significant correlation	p>0.05
Xie et al.	Finnish	18-81	120.1° ± 6.2 to 121.3° ± 6.7	-	p>0.05
Shamout et al.	Jordanian	11-69	122.639° to 124.453°	Increase with age	-
Present Study	North Indian	35-65	114.8° ± 8.341 to 122.3° ± 8.722	Increase with age, significant correlation	p>0.05

Table 4B: Comparison of the results of the present study with previous studies – II

Author	Population	Age-group (years)	Females		
			Range of Mean Gonial Angle (°)	Correlation between Gonial Angle and Age	Inter age-group comparisons
Casey et al.	American	-	-	Constant with age	p>0.05
Ohm et al.	Norwegian	18-86	123.2° ± 6.6 to 127.7° ± 8.2	Increase with age, significant correlation	p>0.05
Xie et al.	Finnish	18-81	123.2° ± 6.6 to 124.1° ± 6.3	-	p>0.05
Shamout et al.	Jordanian	11-69	121.821° to 127.258°	Increase with age	-
Present Study	North Indian	35-65	114.7° ± 5.227 to 122.65° ± 5.413	Increase with age (except gp.1 > gp.2,3) significant correlation	p>0.05

Table 4C: Comparison of the results of the present study with previous studies – III

Author	Population	Age-group (years)	Sexual Dimorphism	Age - wise comparisons between Males and Females
Casey et al.	American	-	Absent	Females > Males
Ohm et al.	Norwegian	18-86 yrs	Absent	Females > Males
Xie et al.	Finnish	18-81 yrs	Absent	Females > Males
Shamout et al.	Jordanian	11-69 yrs	Absent	Males > Females
Present Study	North Indian	35-65 yrs	Absent	Females > Males (all age - groups, except group 2)

morphometric measurement. Besides that, the other factors which are responsible are the non-uniformity of the sample size used in independent studies, different radiographic machines with inherent magnifications unique to each one, different morphometric techniques used and genetically acquired racial differences predisposing to biomechanical and physiological variations existing among different groups of people.

Therefore, direct comparison between results of various authors across the globe is a difficult task.

When Mann Whitney were applied to analyze the differences in successive age groups of males, none of them were calculated to be statistically significant ($p>0.05$) (Table 2). Same observations were recorded in females also (Table 2). Xie et al. (13) and Ohm and Silness (9) have reported similar results in both the sexes, whereas Casey and Emrich (12) have reported the same for females (Table 4A and 4B). Female mean gonial angle values showed higher values than males in all age groups in the present study, similar to the studies carried out by Casey and Emrich (12) in American population, Ohm and Silness (9) and Xie et al. (13) (Table 4C). The possible explanation for these gender differences is that in general, men have greater muscle mass and power in comparison to females and stronger masticatory muscles have been shown to be associated with smaller gonial angles. Also, various Anatomy textbooks mention the presence of a wider mandibular angle in the female mandible as a distinguishing feature from the male mandible (17). In sharp contrast to this, in a recent study by Shamout et al. (15), male gonial angle values were found to be greater than females (Table 4C). However, sexual dimorphism was not observed for gonial angle in the present study, similar to past studies conducted by Shamout et al (15), Casey and Emrich (12), Ohm and Silness (9) and Xie et al. (13) (Table 4C).

Taking into consideration the limitations of sample size and the non-availability of information such as tooth to tooth contact and chewing habits, the present study suggests a multifactorial approach for future research. All these factors which can possibly contribute to variations in the mandibular morphology should be explored further to firmly establish the effect of age and gender related changes of bone tissue resulting in altered mandibular basal bone morphological characters.

Conclusion

The results of the present study concluded that age had a significant influence on the gonial angle but sex affected the gonial angle only to a certain extent. Gonial angle size presented a significant positive correlation with age in both the sexes, but sexual dimorphism was not observed.

References

1. Huumonen S, Sipila K, Haikola B, et al. Influence of edentulousness on gonial angle, ramus and condylar height. J Oral Rehabil 2010; 37(1): 34-8.

2. Shaw RB, Katzel EB, Koltz PF, Kahn DM, Girotto JA, Langstein HN. Aging of the mandible and its aesthetic implications. Plast Reconstr Surg 2010; 125(1): 332-42.

3. Saini V, Srivastava R, Rai RK, Shamal SN, Singh TB, Tripathi SK. Mandibular ramus: an indicator for sex in fragmentary mandible. J Forensic Sci 2011; 56(Suppl 1): S13-6.

4. Juodzbalys G, Wang HL, Sabalys G. Anatomy of Mandibular Vital Structures. Part II: Mandibular Incisive Canal, Mental Foramen and Associated Neurovascular Bundles in Relation with Dental Implantology. J Oral Maxillofac Res 2010; 1(1): e3.

5. Bayat M, Ja'farian M, Habashi OG. Correlation between gonial angle and different variables after bilateral sagittal split ramus osteotomy. J Dent (Tehran) 2006; 3(1): 19-23.

6. Gungor K, Sagir M, Ozer I. Evaluation of the gonial angle in Anatolian populations: from past to present. Coll Anthropol 2007; 31(2): 375-8.

7. Potgieter PJ, Monteith BD, Kemp PL. The determination of free-way space in edentulous patients; a cephalometric approach. J Oral Rehabil 1983; 10(4): 283-93.

8. Ingervall B, Thilander B. Relation between facial morphology and activity of masticatory muscles. J Oral Rehabil 1974; 1(2): 131-47.

9. Ohm E, Silness J. Size of the mandibular jaw angle related to age, tooth retention and gender. J Oral Rehabil 1999; 26(11): 883-91.

10. Fish SF. Change in the gonial angle. J Oral Rehabil 1979; 6(3): 219-27.

11. Raustia AM, Salonen MA. Gonial angles and condylar ramus height of the mandible in complete denture wearers-a panoramic radiograph study. J Oral Rehabil 1997; 24(7): 512-6.

12. Casey DM, Emrich LJ. Changes in the mandibular angle in the edentulous state. J Prosthet Dent 1988; 59(3): 373-9.

13. Xie QF, Ainamo A. Correlation of gonial angle size with cortical thickness, height of the mandibular residual body and the duration of edentulism. J Prosthet Dent 2004; 91(5): 477-82.

14. Sakar O, Sulun T, Ispirgil E. Correlation of the gonial angle size with residual ridge resorption in edentulous subjects. Balk J Stom 2008; 12: 38-41.

15. Shamout RA, Ammoush M, Alrbata R, Habahbah AA. Age and gender differences in gonial angle, ramus height and bigonial width in dentate subjects. Pak Oral Dent J 2012; 32(1): 81-7.

16. Moffett BC. The temporomandibular Joint. In: Sharry JJ. Complete Denture Prosthodontics. 2nd Ed. New York: Mc Graw Hill, 1968, pp 82.

17. Weinmann JP, Sicher H. Bone and bone, fundamentals of bone biology. St Louis: The CV Mosby Co, 1947, pp-178-80.

18. Ghosh S, Vengal M, Pai KM. Remodelling of the human mandible in the gonial angle region: a panoramic, radiographic, cross-sectional study. Oral Radiol 2009; 25: 2-5.

19. Dutra V, Devlin H, Susin C, Yang J, Horner K, Fernandes AR. Mandibular morphological changes in low bone mass edentulous females: evaluation of panoramic radiographs. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2006; 102(5): 663-8.

20. Israel H. The failure of aging or loss of teeth to drastically alter mandibular angle morphology. J Dent Res 1993; 52(1): 83-90.