Original Article

Correlation of the Gonial Cortical Width of Mandible with Age and Gender: A Radiographic Study in North-Indian population

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Abstract: Background: Gonial Index (GI) is a radiomorphometric measurement of gonial cortical thickness of the mandible i.e. the thickness of the inferior cortical border in the region of mandibular angle. Objectives: To examine the correlation of gonial index/gonial cortical width with age and gender in a group of North-Indian population of Haryana. Methods: 60 adult human orthopantomographs were evaluated and divided into six age groups (35-65 years) with equal number of males and females. Gonial Index was measured bilaterally on every radiograph. The measurements were analyzed for interactions with age and sex, using SPSS (Stastistical Package for Social Studies) software version no. 18. The tests employed were Kruskal-Wallis, Mann-Whitney and the unpaired T-test. Results: The male mean gonial index values ranged from 1.92 mm ± 0.307 to 2.48 ± 0.448, whereas the female mean gonial index values ranged from 1.69 mm ± 0.329 to 2.17 mm ± 0.264. Gonial index showed no correlation with age in both the sexes. Female gonial index values were lower than males in majority of the age groups. Sexual dimorphism was also recorded as the difference between the mean gonial index values of males and females was statistically significant ($p<0.05$). Conclusion: The gonial index remained independent of age, but it was influenced by the variations of gender to a significant extent.
Key Words: Gonial index, mandibular angle, angular cortical thickness, panoramic radiographs, sexual dimorphism

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INTRODUCTION

The angle of the mandible bone presents with a lateral point occupying its extreme posterior portion in the inferior-most region of the mandible.[1] This point of the mandibular angle is termed as the "Gonion", coined from the Greek word "ywvtx" i.e. angle.[2] Gonial Index (GI), a linear radiomorphometric index of mandible, devised by Bras et al;[3] is the measurement of the angular cortical thickness i.e. the width of the inferior cortical border of the mandible bone at the gonial angle. The terms "Gonial Cortical Width (GCW)" and "Angular Cortical Width (ACW)" are synonymously used for the same.

Bras et al [3,4] had extensively worked with the dental panoramic radiographs to investigate the changes in the cortical thickness at gonial angle, both in normal individuals of different ages and also in chronic renal failure patients who are known to develop complications of osteoporosis. It was observed in their studies that the cortical thickness at the gonial angle of the normal group is relatively constant after the fifteenth year of life, except in postmenopausal women of 60 years and older, whereas reduction in cortical bone was

recorded in patients suffering from chronic renal failure. Kribbs et al [57] have also reported that osteoporosis patients present with a thinner gonial cortex than the normal population.

Previous studies reported in literature have mostly focused on the usefulness of gonial index in the interpretation of bone loss.[3,5,8] But effective standardization and hence best utilization of the index can be possible only if its variations are studied across different age bands and among both the genders. This data will also prove to be beneficial in clinical dental practice as it would provide vital information about the morphometry of gonial cortex required for prosthesis and other implants. There is paucity of such literature establishing the correlations of gonial index or the gonial cortical width with age and sex in a normal population. Hence, the present study was conducted with the aim of analyzing these correlations of gonial cortical width/gonial index associated with age and gender in a group of North-Indian population of Haryana (a state of India).

MATERIALS AND METHODS

The study sample and design

This study was conducted in the department of Anatomy, Pt. B.D. Sharma Post Graduate Institute of Medical Sciences, Rohtak (Haryana, India) using 60 adult dental panoramic radiographs i.e. orthopantomographs; 30 males and 30 females, ranging from 35 to 65 years of age. The radiographs were obtained from department of Periodontology, of 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, age and sex of the patient 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 or where lower border of mandible, posterior border of the ramus or the condyle were not readable to allow proper measurements of the angle on both sides.
5. Radiographs in which the inferior cortical borders of mandible were not clearly identified.
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 whole 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

Gonial Index (GI) was measured according to the technique described by Bras et al, [3] using vernier calipers. It was measured as the mandibular cortical width on the bisectrix of the mandibular angle formed between the intersection of two tangent lines. One of these lines was drawn tangent to the lower border of mandible and the other was drawn tangent to the posterior border of the ramus of mandible (Figure1). Gonial index was measured bilaterally on all radiographs and the mean of right-sided and left- sided measurements was calculated for every radiograph.

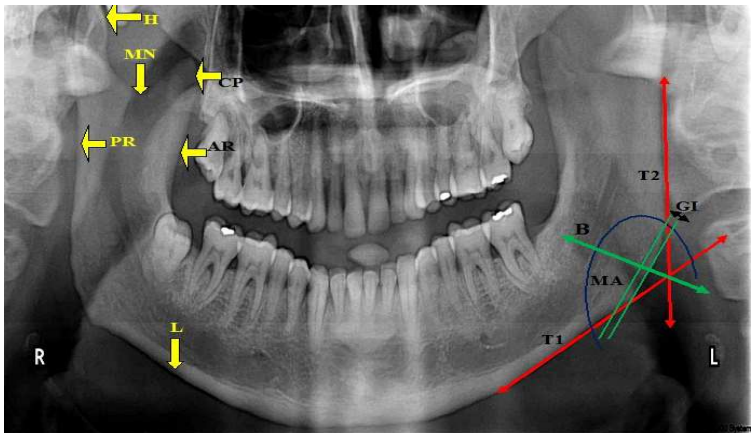

Figure 1: Measurement of Gonial Index (GI):- **T1** – Line tangent to the lower border of the mandible. **T2** – Line tangent to the posterior border of ramus of the mandible. **B** – Bisectrix of the angle formed between **T1** and **T2** i.e. **MA**- Mandibular Angle. **GI** – Mandibular cortical thickness measured on **B**. Other anatomical landmarks: L-Lower border of mandible, PR- Posterior Ramus of mandible, AR- Anterior Ramus of mandible, CP- Coronoid Process, H- Head of mandible, MN-Mandibular notch.

STATISTICAL ANALYSIS

Comparisons of the mean values of gonial index 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. Kruskal-Wallis and Mann-Whitney tests were used for inter- and intra-age-group comparisons. Unpaired T-Test was used to determine the presence of sexual dimorphism.

RESULTS

The range of gonial index values recorded for males in the present study is shown in Table No. I. In males, the mean gonial index values ranged from 1.92 mm ± 0.307mm to 2.48 mm ± 0.448 mm. There was no uniform trend of either increase or decrease in values with increasing age (Fig. 2). The highest mean gonial index value in males was observed in group 3 (46-50 years), whereas the lowest mean gonial index values in males was noted in group 2 (41-45 years). The difference in the mean gonial index values in the 6 different age groups in males was not found to be statistically significant by Kruskal Wallis Test ($p>0.05$) (Table I). The range of gonial index values recorded for females in the present study is shown in Table II. In females, the mean gonial index values ranged from 1.69mm ± 0.329 to 2.17mm ± 0.264. As was the case with males, there was no uniform trend of increase or decrease in values with increasing age (Fig. 2). The highest mean gonial index value in females was seen in group 4(41-45 years) and the lowest mean value in females was seen in group 1(35-40 years). The difference in the mean gonial index values in six different age groups of females was also not found to be statistically significant ($p>0.05$); in similarity with the males (Table II). There was no significant correlation observed between age and mean gonial index values in both the sexes ($p>0.05$). However the value of the correlation coefficient calculated was greater for females than males (Fig. 3). The mean gonial index values were compared separately for successive age groups for both males and females, using Mann-Whitney tests. These inter-age-group comparisons showed statistically insignificant differences between all the groups, in both the genders. (Table III). Female mean gonial index values showed lower values than male mean gonial index values in all age-groups except for groups

2&4 (Table IV, Fig. 2). In group 2 (41-45 years), female mean gonial index was equal to the male mean gonial index whereas in group 4 (51-55 years), the female mean gonial index was greater than that of male gonial index. However, all these differences were statistically not significant (Table IV). The overall male mean gonial index value was higher than its female counterpart (Fig. 4) and this difference was found to be statistically significant by the unpaired T- test (Table V). Hence, sexual dimorphism was observed in gonial index.

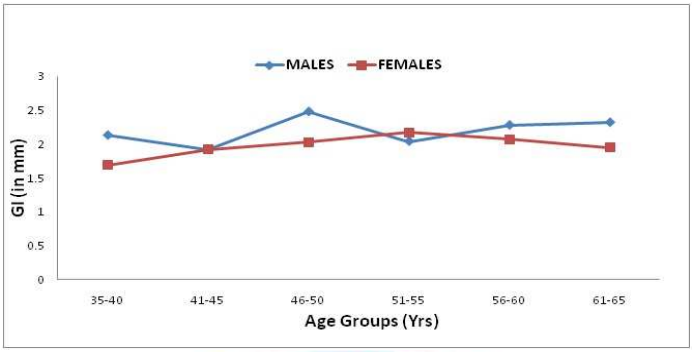

Figure 2: Graph depicting the trend of mean Gonial Index (GI) values with increasing age in males and females.

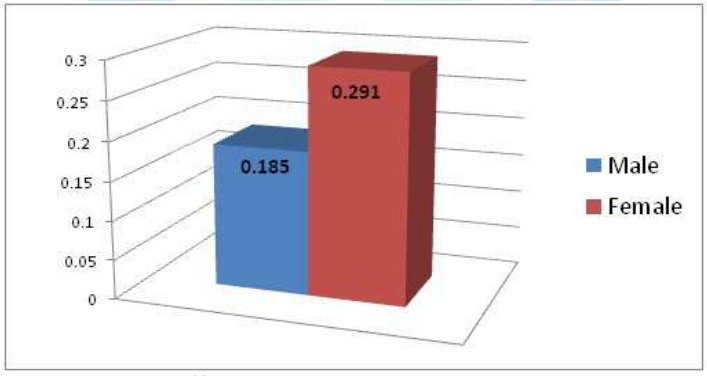

Figure 3: Pearson's correlation-coefficient (r-values) between age and mean Gonial index (GI) in males and in females.

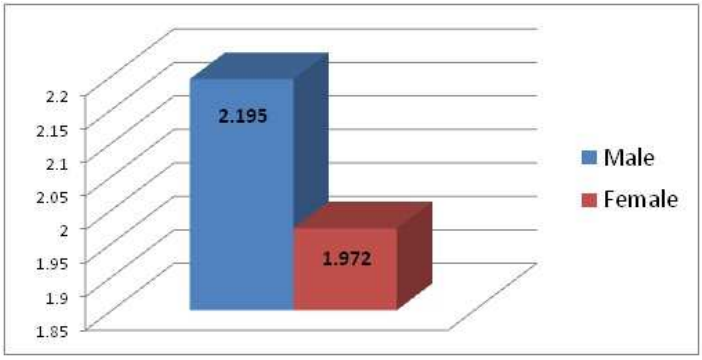

Figure 4: Comparison of the mean Gonial index between males and females.

Table I: Gonial Index (GI) values (in mm) in Males in different age- groups

Age Group		No of Cases (n)	Males		Kruskal Wallis Test (p-value)
No	**In yrs**		**Range**	**Mean GI ± S.D.**	
1	35-40	5	2-2.5	2.13 ± 0.208	p > 0.05
2	41-45	5	1.4-2.15	1.92 ± 0.307	
3	46-50	5	1.85-3	2.48 ± 0.448	
4	51-55	5	1.75-2.65	2.04 ± 0.416	
5	56-60	5	1.85-3	2.28 ± 0.434	
6	61-65	5	1.75-3	2.32 ± 0.518	

Table II: Gonial index (GI) values (in mm) in Females in different age-groups

Age Group		No of Cases (n)	Females		Kruskal Wallis Test (p-value)
No	**In yrs**		**Range**	**Mean GI ± SD**	
1	35-40	5	1.4-2.15	1.69 ± 0.329	p > 0.05
2	41-45	5	1.4-2.5	1.92 ± 0.409	
3	46-50	5	1.75-2.35	2.03 ± 0.22	
4	51-55	5	1.8-2.5	2.17 ± 0.264	
5	56-60	5	1.65-2.75	2.07 ± 0.41	
6	61-65	5	1.3-2.45	1.95 ± 0.436	

Table III: Comparison of the mean Gonial index (GI) values between different age groups (Mann-Whitney Tests)

Age groups compared		**Males**	**Females**
Group No.	**In yrs**		
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

Table IV: Age-wise comparisons between male and female mean Gonial index (GI) values (Mann-Whitney tests)

Age Group No.	**Age-group (Yrs)**	**Mean Male GI (mm) ± S.D.**	**Mean Female GI (mm) ± S.D.**	**p-value**
1	35-40	2.13 ± 0.208	1.69 ± 0.329	p > 0.05
2	41-45	1.92 ± 0.307	1.92 ± 0.409	p > 0.05
3	46-50	2.48 ± 0.448	2.03 ± 0.22	p > 0.05
4	51-55	2.04 ± 0.416	2.17 ± 0.264	p > 0.05
5	56-60	2.28 ± 0.434	2.07 ± 0.41	p > 0.05
6	61-65	2.32 ± 0.518	1.95 ± 0.436	p > 0.05

Table V: Mean Gonial index (GI) in Males vs. Females (Unpaired T-Test)

Radiomorphometric Index	**Cases compared**		**Mean GI (mm) ± SD**		**p-value**
	Male	**Female**	**Male**	**Female**	
GI	30	30	2.08 ± 0.422	2.31 ± 0.544	**p < 0.05**

Table VI: Comparison of the results of the present study with previous studies-I

Author	Population	Age-group	MALES		
			Range of Mean Gonial index	Correlation between Gonial index and Age	Inter age- group comparisons
Bras et al [3]	Netherish	0-69 yrs	1.45 mm ± 0.26 to 1.6 mm ± 0.32	Relatively constant over age	-
Ledgerton et al [9]	British	25-74 yrs	-	-	-
Knezovic et al [10]	Croatian	48-86 yrs	-	Decrease with age	-
Beatriz et al [11]	Brazilian	17-70 yrs	1.08 mm ± 0.15 to 1.37 mm ± 0.37	Decrease with age	p<0.001
Present Study	North Indian	35-65 yrs	1.92 mm±0.307 to 2.48 mm±0.448	No uniform trend, insignificant correlation	p>0.05

Table VII: Comparison of the results of the present study with previous studies-II

Author	Population	Age-group	FEMALES		
			Range Of Mean Gonial index	Correlation Between Gonial index And Age	Inter age-group comparisons
Bras et al [3]	Netherish	0-69 yrs	0.84 mm ± 0.26 to 1.64 mm ± 0.27	Constant till 59 yrs, after that distinctly lower	-
Ledgerton et al [9]	British	25-74 yrs	0.5 mm to 2.95 mm	Gradual decrease till 60 yrs, after that sharp decrease	p<0.001
Knezovic et al [10]	Croatian	48-86 yrs	-	Gradual decrease till 60 yrs, after that sharp decrease	-
Beatriz et al [11]	Brazilian	17-70 yrs	1.06 mm ± 0.26 to 1.25 mm ± 0.23	Decrease with age	p<0.05
Present Study	North Indian	35-65 yrs	1.69 mm±0.329 to 2.17 mm±0.264	No uniform trend, insignifican correlation	p>0.05

Table VIII: Comparison of the results of the present study with previous studies-III

Author	Population	Age-group	Sexual Dimorphism	Age - wise comparison between Males & Females
Bras et al [3]	Netherish	0-69 yrs	Absent	No significant differences
Ledgerton et al [9]	British	25-74 yrs	-	-
Knezovic et al [10]	Croatian	48-86 yrs	Present	-
Beatriz et al [11]	Brazilian	17-70 yrs	-	Males > Females
Present Study	North Indian	35-65 yrs	Absent	Males(m) > Females(f), Except Gp.2(m=f), gp.4(m<f)

DISCUSSION

A comparative study of the results of our study with those of previous authors is presented in Tables No. VI, VII&VIII.

The observations made in the present study implied that the gonial index/ gonial cortical width was unaffected by age in both the genders. No significant correlation was observed between gonial index and age in both the sexes in our study. A non-uniform trend was observed in mean values with increasing age in both sexes. In addition to this, the difference in the mean gonial index values in the six different age groups in both the sexes was found to be statistically insignificant. These results of our study are contrary to the results reported by majority of authors like Ledgerton et al, [9] Knezovic et al [10] and Beatriz et al [11] (Tables No. VI &VII). All these authors have reported a negative correlation between gonial index and age in both the genders. Also, the difference in the mean gonial index values in the different

categories of age was calculated to be statistically significant in females by Ledgerton et al [9] and in both males and females by Beatriz et al; [11] in sharp contrast to the present study. The theory of senile reduction in bone mass has been cited by these authors in their support. Whereas, the study conducted by Bras et al[3] (Tables No. VI&VII) showed both similarities and dissimilarities with our study. They reported that in both genders, gonial index values remained relatively constant with age from 15 to 59 years of age but after 59 years, the female gonial index values were distinctly lower because of postmenopausal osteoporosis.

Male mean gonial index values of our study were much higher than those reported by Beatriz et al [11] and Bras et al. [3] Female mean gonial index values recorded in the present study were close to those recorded by Ledgerton et al [9] but were much higher than those presented by Beatriz et al [11] and Bras et al [3] (Tables No. VI&VII). Direct comparisons between the index values is entirely not feasible because of the dissimilarities in the measurement techniques and ethnic variations.

The inter-age-group comparisons done separately for males and females showed statistically insignificant differences between all the age groups, in both the sexes. These results of our study were contradicted by Ledgerton et al [9] and Beatriz et al [11] (Tables No. VI&VII)

Female mean gonial index values were smaller than male mean gonial index values in all age groups of our study except for group 2 (comparable to males) and group 4 (higher than males), similar to the findings of Beatriz et al [11] and Bras et al [3] (Table No. VIII). Also, males recorded higher overall mean gonial index value than females and this difference was statistically significant. Therefore, the most prominent result of our study is the presence of sexual dimorphism observed for gonial index. This result is supported in literature by the studies of Kim et al [12] and Knezovic et al [10] but contradicted by Bras et al [3] (Table No. VIII). These results are attributed to the greater bone density of males and also to the onset of postmenopausal osteoporosis in women.

Considering the limitations of sample size and the magnification factor inherent in panoramic radiography and at same time, keeping in view the derivation of contrasting results with available literature; the present study suggests further research on the subject with an enhanced sample size with inclusion of different ethnicities.

CONCLUSION

The present study concluded that although the gonial index remained independent of age, but it was influenced by the variations of gender to a significant extent.

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