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Original Research Article

Significance of evaluating mandibular parameters for the identification of an individual

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ABSTRACT

Background: Estimating the age of death is a crucial step since it narrows the field of probable identities that must be compared to remains after mass tragedies. Morphological changes in the mandible are mostly driven by an individual's age and occlusal status. The aim of this study was to determine the association of the dimensions of these parameters with the age and gender of an individual with a larger sample size using orthopantograms in the north Indian population.
Methods: A retrospective radio morphometric analysis was performed for panoramic radiographs of 300 (150 males and 150 females). The digital panoramic images were saved in Dicom format and exported to MicroDicom software for linear measurements. The co-relation of study parameters with age was analyzed by one-way ANOVA and assessment of co-relation with sex by applying student's t-test.
Results: The mean values of the right and left gonial angles were higher in females, while the ramus height and bigonial width dimensions were greater in males. However, only the left gonial angle and ramus height showed statistically significant differences with gender ($p<0.05$).
Conclusions: The present study found substantial changes in gonial angle, ramus height, and bigonial breadth based on gender and age in a larger sample size. As a result, these dimensions can be an accurate predictor of an individual's age and sex. Thus, morphometric examination of the mandible can be a useful tool in both identifying individuals and studying growth patterns.

Keywords: Age estimation, Dental, Forensic, Morphometric, Radioanalysis

INTRODUCTION

In the interest of justice, forensic odontology is a subspecialty of dentistry that deals with the right handling, inspection, and evaluation of dental evidence as well as the proper appraisal and presentation of dental results. In mass catastrophes, abuse, and organized crime, it has long been used to identify victims and suspects.[1] At least 60% of the victims of the Bali bombings in 2002 and as many as 79% of the Boxing Day Tsunami victims in Thailand in 2004 were identified only via the examination of dental remains by skilled forensic odontologist.[2,3] The literature has shown a large number of studies using the metric characteristics of the mandible for age and sex determination of an individual in cases where an intact skull is not found.[4,5] It is the strongest and most durable bone in the face and is important for sex determination, especially without a complete pelvis and/or skull. Additionally, the mandible undergoes morphological alterations throughout life and shows a diversification in features in relation to gender. Age-related variations most frequently impact the gonial region, ramus, and condyle of the mandible.[6] Although there are studies regarding the influence of age and gender on the gonial region, the findings of various studies are inconsistent. Some studies show the variation

in gonial angle, bigonial width, and ramus height with age and sex but some studies do not confirm the same. There is a need for the evaluation of these parameters in different populations in order to create an age and sex determination formula for a particular population.[7,8] When skeletal sex and age determination is considered, metric analyses on the radiographs are often found to be of superior value owing to their objectivity, accuracy, and reproducibility. Therefore, the present study aims to determine the association of the dimensions of these parameters with the age and gender of an individual using orthopantograms in the North Indian population in a larger sample size and to derive a formula accordingly.

METHODS

The present retrospective radiomorphometric analysis was performed in the department of oral pathology and microbiology, KGMU, Lucknow. A total of 300 (150 males and 150 females) panoramic radiographs obtained from the archives of the radiology department of the institution between the month of March 2023 to October 2023. The selected radiographs were divided into seven study groups depending upon the age range, i.e., 0-10, 11-20, 21-30, 31-40, 41-50, 51-60 and above 60 years (Table 1).

The radiographs with good quality and without any associated pathologies, fractures, trauma, ongoing orthodontic treatment in the mandible were included for the analysis. The radiographs with any pathologies or any suspected syndromes were excluded. The digital panoramic images were saved in Dicom format and exported to MicroDicom software where linear measurements in mandibular ramus and gonial angle were taken and entered into the excel. The intersection of the tangent line traced to the lower border of the mandible and the line traced to the posterior border of the ramus was measured as gonial angle. The length of a line connecting the two lateral points on the ramus tangent, from the most superior to the most inferior, was used to calculate the ramus height and as a linear distance between the right and left gonia, the bigonial width was calculated as depicted in Figure 1.

The collected data was analysed using a statistical software package International Business Machines Corporation, Statistical Package for the Social Sciences (IBM SPSS version 26.0). The co-relation between the mean values of gonial angle, ramus height and bigonial width with the different age groups included were evaluated with the help of one-way ANOVA test between the research parameters and sex were also examined (p value less than 0.05 was considered significant). While, the association of mean values of gonial angle, ramus height and bigonial width with gender were assessed with student's t test (significance threshold of $p<0.05$). In order to formulate a regression analysis between the tested parameters and age of the individual univariate analysis was performed (R^2=0.50-0.99 considered statistically significant).

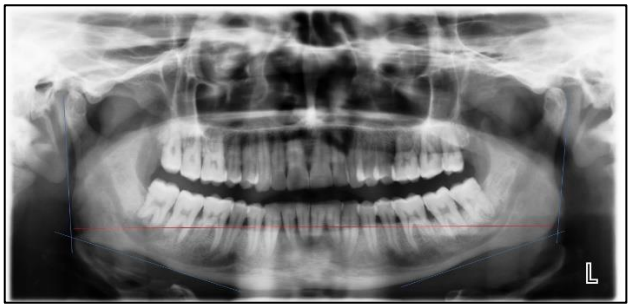

Figure 1: Right and left gonial angle and bigonial width measurements.

RESULTS

The mean values of the right and left gonial angles were maximum in 0-10 years study group 126.92 and 126.82 with a standard deviation of 5.5 and 5.8 respectively. The minimum was seen in the 41-50 years study group with a mean of 121.29 and 121.52 with a standard deviation of 4.44 and 4.49 respectively.

Table 1: Mean values of gonial angle, ramus height and bigonial width with different age groups.

Age in category	Age 0-10 (n=6)	Age 11-20 (n=64)	Age 21-30 (n=114)	Age 31-40 (n=62)	Age 41-50 (n=29)	Age 51-60 (n=15)	Age Above 60 (n=10)	P value
Variables	**Mean±SD**	**Mean±SD**	**Mean±SD**	**Mean±SD**	**Mean±SD**	**Mean±SD**	**Mean±SD**	
Right gonial angle	126.92±5.5	125.67±7.88	123.38±6.25	123.51±5.84	121.29±4.44	123.11±5.58	122.42±5.33	0.05
Left gonial angle	126.82±5.8	125.79±8.24	123.6±6.31	123.64±5.8	121.52±4.49	123.35±5.42	122.53±5.42	0.078
Right ramus height	47.73±2.69	52.15±5.72	55.04±5.87	54.51±6.65	54.8±5.9	60.61±6.23	56.54±5.89	p<0.001
Left ramus height	47.71±2.51	52.23±5.78	55.11±5.96	54.69±6.42	54.77±5.93	60.47±6.3	56.88±6.16	p<0.001
Bigonial width	147.42±2.48	165.62±12.35	167.79±11.82	166.61±11.85	170.15±12.62	173.5±9.68	168.78±12.78	p<0.001

One way ANOVA is used (Data is symmetric). P value less than 0.05 is significant

Table 2: Mean values of gonial angle, ramus height and bigonial width with gender.

Gender	Male (n=150)	Female (n=150)	P value	Confidence interval	
Variables	**Mean±SD**	**Mean±SD**		**Lowe Limit**	**Upper Limit**
Right gonial angle	121.9±6.5	125.6±5.8	0.134	-5.075447305	-2.276552695
Left gonial angle	122±6.6	125.8±5.8	0.045*	-5.205527376	-2.36473929
Right ramus height	57.4±6.2	51.5±4.8	0.019*	4.638757146	7.160042854
Left ramus height	57.4±6.2	51.7±4.9	0.021*	4.512438903	7.047961097
Bigonial width	171.3±11.9	163.1±11.2	0.282	5.541098032	10.7854353

Mean±SD format is used. Independent Sample test is used. P value <0.05 is considered significant

Statistically significant differences according to age were found in the right gonial angle dimensions only and not for the left gonial angle (p=0.05). Ramus height and bigonial width were found to be increased with age with a peak value at 51-60 year of age group. However, in the age group of above 60 years, the parameters were decreasing. The differences came out to be statistically highly significant (p<0.001) (Table 1) (Figure 2).

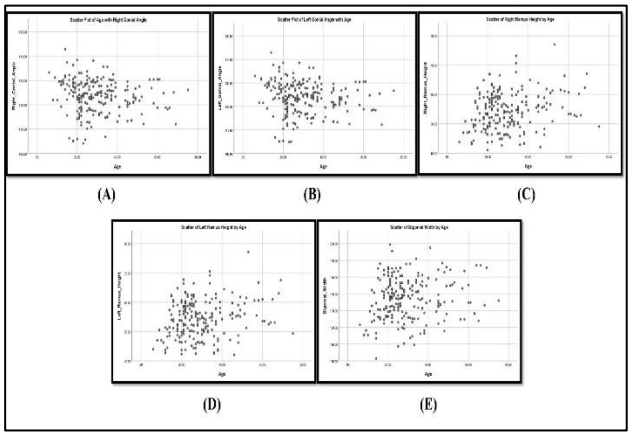

Figure 2: (A) Scatter plot of right gonial angle with age; (B) scatter plot of left gonial angle with age; (C) scatter plot of right ramus height with age; (D) scatter plot of left ramus height with age; (E) scatter plot of bigonial width with age.

The mean values of the right and left gonial angles were higher in females, while the ramus height and bigonial width dimensions were greater in males. However, only left gonial angle and ramus height showed statistically significant differences with gender (p<0.05) (Table 2).

Univariate analysis was performed considering age as a dependent variable. All the variables were coming significant so model can be fitted using each variable separately but the strength of the model (R^2) was weak in every case. Age =-0.279 * right gonial angle + 64.211 (R^2=0.019). Age =-0.263* left gonial angle + 62.279 (R^2=0.017). Age =0.468* right ramus height + 4.206 (R^2=0.051). Age =0.472* left ramus height + 3.999 (R^2=0.051). Age =0.173* bigonial width + 0.833 (R^2=0.026).

DISCUSSION

Age estimation is one of the most important characteristics used to establish the identity of any individual in different legal, forensic, or anthropological research context.[9] One of the important aspects of forensics is to estimate age and gender from the fragmented jaws and dentition especially in the cases of mass disasters. In contrast, procedures based on measurements and morphometry are accurate and more dependable than those based on morphological markings, which are subjective and likely to be incorrect. Mandibles are commonly used for the analysis as it is often recovered largely intact.[10] Orthopantomograph has been advocated routinely by clinicians as the panoramic images do not contain interference with superimposed images and the contrast, brightness enhancement, and enlargement of images provide an accurate and reproducible method of measuring the chosen points. A panoramic radiograph is the most obvious choice for the determination of the mandibular structures with minimum radiation dose with good accuracy and reproducibility for linear and angular measurements.[11]

The mandibular condyle, ramus, and gonial angle, in particular, are often the most sexually dimorphic structures because they are locations linked to the most significant dimorphic morphological variations in size and remodelling during growth. At birth, the gonial angle is regarded as being obtuse, however as children grow and acquire additional teeth, the angle sharpens. According to Jensen and Palling, with old age the angle increases to between 120° and 150°, becoming more similar to the ‘infantile angle’ of 135° to 150°.[12] The gonial angle is a predictor of the steepness of the mandibular plane and may be used to forecast the pattern of facial development. Ramus remodelling with ageing alters the general contour of the face and is notably noticeable in the gonial angle. These changes rely on how the ramus is remodelling in respect to its condyle. The horizontal dimension is represented by the bigonial width, which corresponds to the distance between the right and left gonial angles. Ramus height can be demonstrated by drawing a perpendicular line draw from the highest point of the condylar head to the lowest point of ramus.[13]

In the present study, assessment was done to measure the gonial angle, ramus height and bigonial width on digital panoramic radiographs and to compare between gender and different age groups in dentate patients. This study has taken consideration into a larger sample size as compared to the previous studies and aimed to provide a formula for age estimation using mandibular parameters. While comparing the gonial angle with the included age groups, no statistically significant differences was noted with the left gonial angle, while a significant difference was seen with the right gonial angle (p=0.05). The dimensions of gonial angles were obtuse in the younger 0-10 and 11-20 years of age group. In the adult age groups 21-30 and 31-40, they were noted to become acute and in the older age groups, the dimensions were obtuse. Our result did not correlate with studies done by Izard et al, Ohm and Silness which showed gonial angle increases with age, whereas it shows a bimodal distribution of gonial angle i.e., it decreases from childhood to adulthood and then again increases in old age.[14,15] From infancy to adulthood, the mandible undergoes various growth and developmental changes and the obtuse gonial angle in infancy and childhood gradually becomes acute during adulthood. Age-related decline in muscle forces and the resorption of the alveolar process due to tooth loss causes the gonial angle to become more acute as individuals grow older.[16] This finding in our study was similar to the studies of Bathla et al, Rajkumari et al and Pillay et al who found the difference was not statistically significant, whereas, in the study of Shamout et al, Ghaffari et al, Bhuyan et al and Moron and Gimeno, statistically significant differences were found.[6-8,17-20] In our study, gonial angle dimensions were noted to be more in females as compared to that in males, however the data was statistically significant only for the left gonial angle ($p<0.05$). These findings were similar to Ghaffari et al, Huumonen et al, Moron and Gimeno, and Rajkumari et al but not similar to Shamout et al and Pillay et al Pecora et al.[7,8,17,18,20-22] It has been observed that females have downward and backward rotation of the mandible while males have forward rotation of the mandible leading to wider gonial angles in females.

The ramus height and bigonial width were noted to be increased with age in the present study with a peak value in 51-60 years of age group and differences were statistically significant ($p<0.001$). Our findings were similar to the study of Shamout et al who noticed significant differences, but in contrast with the findings of Bhuyan et al.[7,19] The ramus height and bigonial width were found to be more in males as compared to females. The overall masticatory forces are more in males leading to overall increased dimensions of the mandible. However, in this study, statistically significant differences were seen only in the ramus height ($p<0.05$) and not in the bigonial width. This finding was similar to the findings in the studies of Shamout et al Ghaffari et al Huumonen et al and Bhuyan et al.[7,8,19,21]

Although this study shows an important association of the mandibular parameters with the age and gender of an individual in the north Indian population. This requires further validation in individuals belonging to a different region and ethnic origin to create this as a standard. Also, it would be interesting to study more of the mandibular features for identification purposes.

CONCLUSION

The present study found substantial changes in gonial angle, ramus height, and bigonial breadth based on gender and age in the included sample. As a result, these dimensions are accurate predictors of an individual's age and gender. Also, the ease of getting a radiograph makes the procedure handy. Therefore, it is safe to say that the morphometric examination of the mandible can be a potentially useful tool in future to both identify individuals and studying growth patterns.

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REFERENCES

1. Shamim T. Forensic odontology. J Coll Phys Surg Pak. 2010;20:1-2.
2. Lain R, Griffiths C, Hilton JMN. Forensic dental and medical response to the Bali bombing. Med J Aust. 2003;179(7):362-5.
3. James H. Thai tsunami victim identification overview to date. J Forens Odontostomatol. 2005;23:1-18.
4. Shahabi M, Ramazanzadeh B, Mokhber N. Comparison between the external gonial angle in panoramic radiographs and lateral cephalograms of adult patients with class I malocclusion. J Oral Sci. 2009;51:425-9.
5. Upadhyay RB, Upadhyay J, Agrawal P, Rao NN. Analysis of gonial angle in relation to age, gender and dentition status by radiological and anthropometric methods. J Forens Dent Sci. 2012;4:29-33.
6. Bathla S, Srivastava SK, Sharma RK, Chhabra S. Influence of age on the radiomorphometric indices of the gonial region of the mandible in north-Indian population. Int J Med and Dent Sci. 2014;3:411-20.
7. Shamout RA, Ammoush M, Alrbata R, Hababbah AA. Age and gender differences in gonial angle, ramus height and bigonial width in dentate subjects. Pak Oral Dent J. 2012;32:81-7.
8. Ghaffari R, Hosseinzade A, Zarabi H, Kazemi M. Mandibular dimensional changes with aging in three dimensional computed tomographic study. Journal of Dentomaxillofac Radiol Pathol Surg. 2013;2:6-12.

9. Soomer H, Ranta H, Lincoln MJ, Penttila A, Leibur E. Reliability and validity of eight dental age estimation methods for adults. J Forens Sci. 2003;48(1):149-52.
10. Vodanović M, Dumančić J, Demo Ž, Mihelić D. Determination of sex by discriminant functional analysis of mandible from two Croatian archaeological sites. Acta Stomatol Croat. 2006;40:263-77.
11. Nikenshan S, Sharafi M, Emadi N. Evaluation of the accuracy of linear and angular measurements on panoramic radiographs taken at different positions. Imag Sci Dent. 2013;43:191-6.
12. Jensen E, Palling M. The gonial angle. Am J Orthod. 1954;40:120-33.
13. Alshamout R, Ammoush M, Alrabata R, Alhabahbah A. Age and gender differences in gonial angle, ramus height and bigonial width in dentate subjects. Pak Oral Dent J 2012;32(1):27.
14. Izard G. The gonio-mandibular angle in dento-facial orthopedia. Int J Orthod. 1927;13:578-81.
15. Ohm E, Silness J. size of the mandibular jaw angle related to age, tooth retention and gender. J Oral Rehabil. 1999;26:883-91.
16. Sperber GH, edr. Craniofacial Development. Canada: BC Decker Inc.; 2001:130.
17. Rajkumari S, Nikitha K, Monisha S, Nishagrade S, Thayumanavan B, Murali BA. Role of orthopantamograph in forensic identification: a retrospective study among Chennai population. J Pharm Bioall Sci. 2019;11:S393-6.
18. Pillay S, Ishwarkumar S, Gama DBZ, Pillay P. The morphometry of the angle of mandible and its correlation with age and sex in the eThekwini metropolitan region: a panoramic study. Int J Morphol. 2017;35:661-6.
19. Bhuyan R, Mohanty S, Bhuyan S, Pati A, Priyadarshini S, Das P. Panoramic radiograph as a forensic aid in age and gender estimation: Preliminary retrospective study. J Oral Maxillofac Pathol. 2018;22:266-70.
20. 2Moron CL, Gimeno JAS. Gonial angle growth patterns according to age and gender. Ann Anat. 2018;215:93-6.
21. Huumonen S, Sipila K, Haikola B, Tapio M, Soderholm AL, Remes LT, et al. Influence of edentulousness on gonial angle, ramus and condylar height. J Oral Rehabil. 2010;37:34-8.
22. Pecora NG, Baccetti T, Mcnamara JA. The aging craniofacial complex: a longitudinal cephalometric study from late adolescence to late adulthood. Am J Orthod Dentofac Orthop. 2008;134:496-505.

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