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Evaluation of Antegonial Angle, Antegonial Depth and Gonial Angle in Sex Prediction in the Turkish Pediatric Population of the Eastern Mediterranean Region#

Katibe Tuğçe Temur[1,a,*], Aslı Soğukpınar Önsüren[2,b]

[1]Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Nigde Omer Halisdemir University, Nigde, Turkey
[2]Department of Pediatric Dentistry, Faculty of Dentistry, Mersin University, Mersin, Turkey
*Corresponding author

Research Article

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ABSTRACT

Objectives: In this study, it was examined whether antegonial angle (AGA), antegonial depth (AGD), and gonial angle (GA) are associated with sex in a Turkish pediatric sample to be able to determine a reliable method for sex estimation in children.

Materials and Methods: The study was retrospectively carried out on panoramic radiographs previously taken for children's dental treatments for different reasons. An oral and maxillofacial radiologist measured AGA, AGD, and GA on the right and left sides on panoramic radiographs, and their mean values were calculated.

Results: The mean age of 197 children was 11.5±1.28 years. The results revealed that AGA and AGD significantly differed between the children by sex. However, it was not the case for GA by sex.

Conclusions: Overall, it was concluded that AGA and AGD can be used to estimate sex in the Turkish pediatric population from the Eastern Mediterranean region; nevertheless, GA is not reliable.

Keywords: Sex Prediction, Panoramic Radiography, Child, Adolesan, Mandible.

[a] tugce.uzmez@hotmail.com https://orcid.org/0000-0001-9947-5679 [b] aslisdt@gmail.com https://orcid.org/0000-0002-1934-9945

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Introduction

Sex estimation is a crucial part of research in anthropology and forensic science.[1] In general, the sex of an unidentified person can be determined based on their anatomical features.[2] For sex xestimation, the skull is the most dimorphic and most easily sexed region of the skeleton following the pelvis. In cases where cranial bones are not intact, the mandible play an essential role in sex estimation as it is the most dimorphic, largest, and strongest bone of the skull.[3,4] On the other hand, the morphological features of the mandible vary by sex, occlusal status, age, and race.[1,5]

The sex of an unidentified person can be determined based on data from the morphology and metric features of the skull and mandible, soft tissues, forensic odontology, and DNA analysis of teeth.[6] In sex determination from bones, metric analyses on radiographs are often reported to be generally superior due to their objectivity, accuracy, and replicability.[7,8] Advances as modern panoramic radiography devices offer lower radiation dose and good image quality are particularly important in children and adolescents.[9] Although linear measurements can be made on panoramic radiographs in the literature, it is reported as a helpful method, especially for angular measurements.[10]

Sex differences in neonatal and juvenile skeletal morphology are considered insignificant compared to adults.[11] Apaydın *et al.*[12] report that reliable parameters are needed for sex estimation from juvenile mandibular remnants. On the other hand, it is known that skeletal features vary by population; therefore, population-specific standards should be established.[13]

In this study, it was evaluated whether antegonial angle (AGA), antegonial depth (AGD), and gonial angle (GA) differ by sex in a group of Turkish children from the Eastern Mediterranean region to reveal a reliable method to estimate sex in children.

Materials and Methods

The ethical approval for our study was granted by the Clinical Research Ethics Committee of Kahramanmaraş Sütçü İmam University (Meeting No: 2021\29, Decision No:05).

This present study was retrospectively carried out on panoramic radiographs taken for different reasons for dental treatments in the pedodontic clinic between 2019-2021. No additional radiographs were taken in the study. Panoramic radiographs with high image quality, which do not interfere with measurements that fully contain the study parameters, were included in the study. Yet, the radiographs of patients with facial asymmetry, craniofacial anomalies, orthognathic surgery, history of facial trauma, and temporomandibular joint disorder and the radiographs with low image quality were excluded from the study. Out of approximately 1100 radiographs, 197 selected according to study criteria were included in the study. The cases were evaluated by dividing them into 3 groups according to age.

The radiographs in this study were taken by the same staff on the GENDEX GDP -700 (Magnification 1.3) (Kavo Kerr, Biberach, Germany) device at 66 Kv, 6.3 mA 14 sec. in the child module following the manufacturer's recommendations.

AGA, AGD, and GA are the anatomical indices located in the mandible on panoramic radiographs. The panoramic radiograph was recorded on the computer in 2441x1149 pixels, 300 dpi resolution, 8-bit color depth and Joint Photographic Experts Group (JPEG) format. All measurements were made on a 15.6 inch HP LED display notebook (HP, Hq-TRE 71025, Germany) with a resolution of 1366 × 768 pixels in a dark room and silent.

An oral and maxillofacial radiologist measured these indices on the right and left sides using while the ruler tool Adobe Photoshop CS6 was used for linear measurements, the angle tool Image J (ImageJ, a public domain program; US National Institutes of Health, Bethesda, MD, https://imagej.nih.gov/ij/) was used for angular measurements.[14,15]

Mandibular indices included in the study:

- AGA: It was measured tracing to the angle of two lines parallel to the antegonial region which will intersect at the deepest point of the antegonial notch.[15] (Figure 1a)
- AGD: It was measured as the distance between a line parallel to the lower cortical border of the mandible and a line perpendicular to this line from the deepest point of the antegonial notch concavity.[15] (Figure 1b)
- GA: It was measured as the distance between a line tangent to the lower border of the mandible and another line tangent to the distal border of the ramus.[15] (Figure 1c)

To analyze intra-observer reliability, 30% of randomly selected panoramic radiographs were remeasured 2 weeks later.

Statistical Analysis

Statistical analyses were performed using the Jamovi (Version 1.0.4) software. Descriptive statistics (mean, standard deviation, minimum and maximum values, etc.) were calculated for all measurements. Wilcoxon test was used for differences between right and left measurements. Non-numeric data were presented as numbers and percentages. One-way analysis of variance (ANOVA) was performed to reveal the link between the all measurements by sex and age.

Spearman correlation analysis was used to assess Metrics correlation in within-observer measures. In all analyses, a probability level of <0.05 was considered statistically significant.

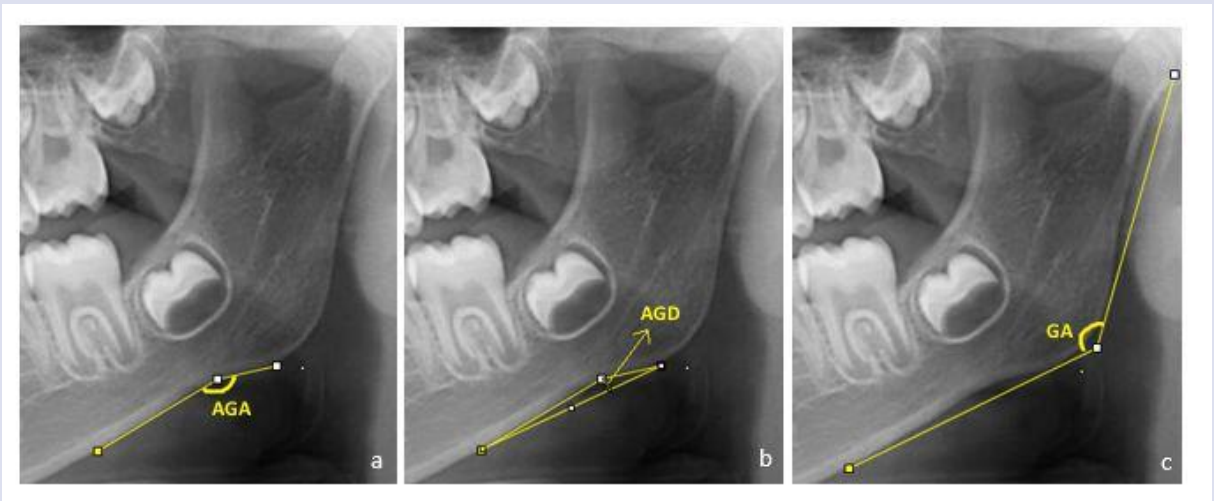

Fig 1a, b, c: AGA, AGD and GA measurement in panoramic radiography

Results

The mean age of 197 patients aged between 4 and 15 years was 11.5±1.28 years. The number of men included in the study was 109, and the number of women was 88. It was determined that there was no statistically significant difference between the ages of boys and girls (p=0.741) (Table 1). The intra-rater reliability coefficients for AGA, AGD, and GA were 0.891, 0.885, and 0.912, respectively.

Since there was no statistically significant difference between all measurements made from the right and left sides, the evaluation was made by taking the average of the right and left sides for each measurement.

AGA and AGD values in the 4-7 and 8-11 age groups show statistically significant differences according to gender. In these age groups, girls have higher AGA values and smaller AGD values than boys. It was determined that GA did not differ according to gender in all age groups. (Table 2).

Table 1. Evaluation of age statistical difference by gender with Student's t test

	Group	N	Mean	Median	SD	SE	p-value
Age	Boy	109	11.44	12	2.79	0.27	0.741
	Girl	88	11.58	12	3.1	0.33	

*Significant P<0.05

Table 2. Evaluation of the relationship between the parameters of gender and age groups with ANOVA test

Parameters	Age	Girl	Boy	p-value
AGA	4-7	167.8 (5.8)	165.8 (6.4)	0.022*
	8-11	169.9 (5.26)	166.06 (5.93)	0.007*
	12-15	166.72 (5.15)	165.66 (5.68)	0.388
	p-value	0.093	0.077	
AGD	4-7	1.42 (0.51)	1.96 (0.69)	0.048*
	8-11	1.05 (0.51)	1.51 (0.71)	0.002*
	12-15	1.41 (0.6)	1.52 (0.72)	0.468
	p-value	0.074	0.191	
GA	4-7	131.49 (5.8)	132.79 (5.5)	0.909
	8-11	128.34 (4.82)	129.46 (4.12)	0.324
	12-15	127.9 (6.17)	125.88 (5.96)	0.146
	p-value	0.354	0.035*	

*Significant P<0.05

Discussion

The results revealed that children aged 4-7 and 8-11 in the Eastern Mediterranean region significantly differed in AGA and AGD values by sex, but it was not the case for GA.

The previous research utilized different parameters in the mandible for sex determination within the pre-adult population. However, the results are often controversial.[12,13,16-19]

Ulusoy *et al.*[16] have recently evaluated linear measurements (ramus height, maximum ramus width, minimum ramus width, bigonial width, bicondylar width, and gonial angle) among 3-13-year-olds and reported that all linear measurements were higher in males although gonial angle did not significantly differ by sex, as in this study.

Akhlaghi *et al.*[20] reported that mandibular anthropometric measurements did not significantly by sex in cadavers under the age of. Nevertheless, they found bigonial width and the distance between the gnathion-gonion were greater among 12-19-year-old men.[13] Unlike this study, both Ulusoy *et al.* and Akhlaghinin *et al.* did not evaluate AGA and AGD

Although the morphological changes in the antegonial region have clinical importance (i.e., a guide region in osteotomy in orthognathic surgery) and can be utilized for sex determination in forensic cases, the literature reported it to have received little attention so far.[15,20]

Yet, current studies have shifted their attention to the antegonial region. In a study, Apaydın *et al.* evaluated mandibular morphometric differences among 5-50-year olds and reported that AGA showed a statistically significant difference in both prepubertal and postpubertal periods of only those aged 5-7 years by sex. Accordingly, AGA was higher in girls than in boys. Yet, GA did not significantly differ by sex, similar to this study.[21]

In their study evaluating children in the prepubertal period, Apaydın *et al.*[12] also suggested that AGA and AGD could be used to determine sex in the mandible among 5-7-year-olds. They found that boys had a lower AGA value than girls but did not consider GA. Their results overlap ours, where we found the female participants had wider AGA and smaller AGD.

On the other hand, Dutra *et al.*[15] evaluated the same parameters as ours in an adult population and concluded

reported that GA did not significantly differ by sex. Yet, morphology of the antegonial region was reported to be affected by sex and dentition status.

In the study of Chole *et al.* with patients aged 15-66 years, men had significantly smaller gonial and antegonial angles and greater antegonial depth than women, overlapping our findings. These results were explained by sex-hormonal differences affecting bone metabolism.[20] Moreover, it was reported that the narrower gonial angle in men may be due to intense muscle activity.[22] However, considering this study population, it is not an expected situation to have a gender-related hormonal difference.

Upadhyay *et al.* analyzed the relationships of the gonial angle with dental status, sex, and age and reported no significant difference in the gonial angle in the primary dentition period and that there was a narrowing in the gonial angle toward the ages of 25-30.[23] Another study voiced that while the gonial angle is 140.17°±5.9° in the primary dentition period, it decreases to 123.61°±6.9° in late dentition.[24] Consistent with the literature, we could not reach statistically significant findings for the gonial angle in all three age groups by gender, but we obtained a greater and smaller gonial angle among 4-7-year-olds and 12-15 year-olds, respectively.

Previous findings may have differed depending on factors such as population-specific morphological changes, genetics, environmental factors, sample size, and observer experience.

On the other hand, we evaluated the mean values of measurements since there was no statistically significant difference between the measurements from the right and left sides. Similarly, the rule of thumb in the literature is to evaluate the mean values of measurements or the measurement from the single side if there is no statistical difference between the radiological measurements.[5,8,16]

Moreover, panoramic radiographs are known to have disadvantages such as being sensitive to magnification, geometric distortion, and positioning errors.[10] While angular measurements are highly reliable in panoramic radiographs, horizontal and lineer measurements have low reliability.[25,10]

Cone beam computed tomography (CBCT) eliminates the disadvantages of panoramic radiographs such as superposition, magnification, and distortion, allowing true-size accurate scanning in all mandible directions.[26,27] From this point of view, it is a limitation that the study did not work on CBCT images. However, since panoramic radiographs are the imaging method frequently used in pediatric clinics and low radiation exposure, measurements made in radiographs taken with correct positioning may be useful in children. Future studies with larger samples of children are needed to support our findings.

Conclusions

Overall, it was concluded that AGA and AGD may be helpful in estimating sex in children from the Eastern Mediterranean region, but it was not the case for GA.

Conflicts of Interest Statement

The authors declare that there are no conflicts of interest regarding the publication of this study.

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