

Research Report

Sex determination using gonial angle during growth spurt period: a direct examination

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ABSTRACT

Background: In forensic medicine and medicolegal, sex determination is an important step of an identification process. Parts of human skeleton that can be used for identification are cranium, pelvis, and mandible. There are several anthropometry tools in sex determination methods i.e shape of mandible, mental, gonial angle. Gonial angle in adults is an excellent tool for sex determination. However, bone density and masticatory force may change the value of gonial angle. **Purpose:** The objective of this study was to examine sex determination method using gonial angle in children during growth spurt period and external factors. **Methods:** There were 104 randomly selected subjects (51 boys and 53 girls) aged 7-12 years old. The subjects were grouped into prolonged sun exposure-hard diet (group A) and low sun exposure-soft diet (group B). The measurements were made using goniometer. **Results:** The mean of gonial angle of female children was greater than the male children. There was no significant difference between group A and B. **Conclusion:** Gonial angle can be used for sex determination in grow spurt period, and external factors did not affect sexual dimorphism.

Keywords: sexual dimorphism, gonial angle, goniometer

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INTRODUCTION

Geographically, Indonesia is a country prone to natural disasters. In case of natural disaster, some deceased are found in a damaged or unrecognizable state. Therefore, sex determination is a crucial identification in forensic and medicolegal anthropology to determine the identity of the deceased.^{1,2}

Mandible is one of the valid parts of the skull for sex determination. Mandible is the strongest facial bone that curves horizontally, convex in the two ramus of mandibles, and ascends to the posterior end of the mandibular corpus.^{3,4} Parts of the mandible that can be used in sex determination are the symphysis, the corpus, ramus, and the gonial angle (GA).⁵⁻⁹

GA is formed from two lines, the inferior border of the mandibular corpus and the posterior border of the mandible ramus.¹⁰ Physiologically, GA is blunt at birth (175°) and shrinks in the second year (140°). In adults, the angle is between 110°-120° whereas in the old age group, gonial angles again increased to 140° due to tooth loss.^{11,12} GA growth can be directly measured using odonto pantomograph (OPG) and goniometer for sex determination.^{10,13} However, in the event that mandibular skeleton is left, OPG cannot be

used. Thus, a direct measurement method with a goniometer is needed.

Growth spurt and external factors such as food texture and vitamin D from sun exposure can affect GA measurement.^{14,15-17} The mandible development during growth spurt does not affect the GA.² In addition, after bone growth and development stops due to hormonal effects, the difference will appear clearly.¹⁸ Therefore, internal and external factors must be considered. This study aimed to examine gonial angle method as sex determination tool of children during growth spurt and external factors.

MATERIALS AND METHODS

This was an observational analytic study with a cross sectional design. Ethical clearance was obtained from the Health Research Ethical Clearance Commission, Faculty of Dental Medicine, Universitas Airlangga 051/HRECC. FODM/II/2019. The participants of the study were children 7-12 years old totaling 104 subjects (51 male children and 53 female children). The participants were Kalijudan I Public Elementary School of Kalijudan area, Mulyorejo District and Muhammadiyah 4 Private Elementary School

of Kertajaya area, Gubeng District, Surabaya. The subjects were divided into 2 groups. Subjects with prolonged sun exposure and hard diets (Group A), and subjects with low sun exposure and soft diets (Group B).^{15,16,19}

Subject criteria were no genetic and physical defects, no cross-bite, and median line shifts. Parents/guardians have signed an agreement that the data obtained would be used for research purposes and given a questionnaire to confirm the information provided by the subjects. Subjects were interviewed regarding dietary habits and outdoor activities.

The tools and materials were goniometer, gonial angle (GA), cross stickers, stationery. Right and left GA were measured by placing cross stickers onto the inferior parts of the mandibular corpus and posterior ramus of the mandible (Figure 1).

The measurement was made by one examiner. To examine the reliability between the observers, 10% subjects were randomly selected and re-evaluated after 1 month. The data were collected using Excel (2013 version of Microsoft, Redmond, USA) and statistically analyzed using SPSS (version 21.0 of IBM Corporation, Armonk, New York).

Data obtained from the examiners were tested using Kolmogorov-Smirnov to determine whether the data were normally distributed, then tested with the Kruskal-Wallis Test. The difference between right and left GA was examined by the Mann-Whitney Test. The differences of GA for each sex were tested using independent t-test. The Mann-Whitney Test was used to find out if there were significant differences between the GA groups. The Independent t-test

and the Mann-Whitney test were used to determine the differences between the sexes in group A and B.

RESULTS

The mean of GA measurement confirmed that there was no difference in term of data ($p > 0.05$). The mean of right and left GA showed no significant difference ($p > 0.05$), obtained from each sample (Table 1). Furthermore, there were significant differences between male and female where the mean of GA of female was greater than the male ($p = 0.002$) as listed in Table 2. The mean of GA in Group B showed no significant difference between male and female ($p = 0.001$) (Table 3). In contrast, there was no significant difference in the mean of GA between group A and B ($p = 0.597$).

DISCUSSION

Differences of mandible are pictured in shape and size. In addition, the development of the mandible differs between male and female.²⁰ We found no significant differences between the mean of left and right GA of all male and female samples (130.94 o and 130.93 o, $p = .858$). Research Shahabi et al., (2009)²¹ involving 70 orthodontic patients (48 females and 22 males) aged 15-30 years old resulted in a similar result that there was no difference between the mean of left and right GA using orthopantomogram (OPG) and



Figure 1. A cross sticker is placed inferior to the mandibular corpus and posterior to the mandibular ramus

Table 1. Analysis of right and left gonial angles

Variables	Number of Samples	Mean	Standard Deviation	p-Value
Right GA	104	130.93°	5.22274	0.858
Left GA		130.94°	5.93426	

Note: GA: gonial angle

Table 2. Analysis of gonial angles based on sex

Variables	Number of Samples	Mean	Standard Deviation	p-Value
GA M	51	129.3°	5.5820	0.002
GA F	53	132.4°	4.5879	

Note: GA M: male gonial angle; GA F: female gonial angle

Table 3. Analysis of gonial angles in group A and B

Variables	Number of Samples	M		F		p-Value
		Mean	Standard Deviation	Mean	Standard Deviation	
GA of Group A	51	128.7°	7.2207	132.3°	5.6579	0.061
GA of Group B	53	129.9°	2.4412	132.6°	5.6579	0.001

Note: GA: gonial angle

lateral cephalogram. Another research showed that the mean of GA in lateral cephalograms is 2.2-3.6 degrees greater than panoramic radiographs.²² This insignificant difference can affect the accuracy of forward logistic regression.

The mean of GA is a useful and proven variable in sex determination because there are significant differences between male and female (129.30 and 132.40, $p = 0.002$). Several researches showed that GA is reliable for sex determination in various age groups.^{2,23-26} In contrast, other research found that there was no significance between the mean of male and female GA.²⁷

Research conducted by Hichijo et al., (2015)¹³ and Kono et al., (2017)¹⁵ showed that the mean of GA of soft diet group was higher than the hard diet group. Soft diet can have a negative impact on mandible growth, while hard diet can repair bone damage caused by soft diet during growth.²⁸ In addition, sun exposure is associated with bone health.²⁹ The effect of sun exposure can have a positive impact on bone structure and hormones that control bone mass.³⁰ Kanemura et al., (2016)¹⁶ researched the effect of sun exposure on bone thickness in 5 children aged 6-8 years old for 12 months. The results showed that bone mineral density (BMD) significantly increased in all children who bask in sun exposure for an average of 28.8 minutes/day compared to children who did not bask in the sun, and all children did not experience bone fracture after 2 years of observation. In comparison to this study, we found no significant difference of mean of GA between group A and B ($p = 0.597$). Possible causes are inclusion and exclusion criteria. For future research, it is recommended add other factors to the questionnaire such as race, oral habits, chewing habits, menarche, body mass index (BMI).³¹⁻³⁶

In this study, the goniometer was chosen as the GA measurement method. Goniometer can be used directly on the patient's face. The advantages of a goniometer are simple, unlimited use, inexpensive, and safe.³⁷⁻³⁸ In addition, the disadvantages of goniometer are, first, measurements are carried out one by one per variable.³⁹ Second, the researchers have difficulty determining the inferior border and posterior ramus of the mandible. Gungor et al., (2007)⁴⁰ found that OPG can accurately measure GA and can be used directly on the skull. However, in the event that only skull mandible is left, OPG cannot be used. Therefore, a direct measurement method is needed because in some OPG cases, postmortem (PM) is not possible.⁴¹ This study showed that GA can be used as sex determination tool during growth spurt as the GAs of male and children were different. Mandibular growth in children aged 7-12 years old was not influenced by external factors

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