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Gonial angle growth patterns according to age and gender

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ABSTRACT

Currently there are controversial results about gender and age differences in human gonial angle values. In this context we aimed to ascertain the gender and age differences in the gonial angle values of young Caucasian Mediterranean subjects. We tested the hypothesis of a relation between the gonial angle values and the gender and age of the subjects by means of a prospective study involving 266 subjects. Panoramic radiographs (Cranex Novus®, XMIND Novus® Soredex, France) were carried out in order to measure the gonial angle values. We found significant differences between females and males in the subgroups aged $\leq$10 years old (128.6 ± 3.4 vs 126.8 ± 4.5, p = 0.017), 16–20 years old (119.1 ± 5.6 vs 122.3 ± 7.7, p = 0.011), 21–25 years old (117.6 ± 5.2 vs 120.8 ± 7.0, p = 0.016) and 26–30 years old (117.5 ± 5.4 vs 120.6 ± 5.4, p = 0.019) but not in the subgroup aged 11–15 years old (123.4 ± 5.2 vs 123.5 ± 5.4, p = 0.927). A significant negative correlation was found between age and gonial angle values (r = −0.365, p < 0.001). In sum, females under 10 years of age have significantly higher values than males. The angle values decreased until the age of 11–15 years of age when there were no significant gender differences. Thus, the males aged over 16 years old presented significantly higher values than the females. The decrease in gonial angle values seems to slow or stop from 21 years onwards. Knowledge of the pattern differences will serve for age and gender determination when analyzing human remains.

1. Introduction

Correct assessment of gonial angle values are important in order to establish gender and age when analysing human remains.

In this context, assessment of the anatomic gonial angle values according to age and gender has been analysed before (Gungor et al., 2007; Uthman, 2007; Iseri et al., 2008; Gamba Tde et al., 2016) as panoramic radiography (orthopantomography) a useful tool to measure the gonial angle (Zangouei-Booshehri et al., 2012; Khetani et al., 2013) that offers similar results to lateral radiography (Zangouei-Booshehri et al., 2012).

Nevertheless, the results of such analyses are controversial as to whether there are gender and age differences in gonial angle values. Some authors (Dutra et al., 2004; Chole et al., 2013; Taleb and Beshlawy, 2015) have encountered no relationship between gonial angle values and age while others have (Tarazona et al., 2010; Ogawa and Osato, 2013; Upadhyay et al., 2012; Bhardwaj et al., 2014). The same can be said of gender, as some studies have revealed significant differences between gender (Huumonen et al., 2010; Abu Alhaija et al., 2011; Bhardwaj et al., 2014; Leversha et al., 2016), others, however, have not (Ohm and Silness, 1999; Dutra et al., 2004; Uthman, 2007; Hassan, 2011).

In light of the above, this report analyzes patterns of gonial angle evolution with growth that will serve as a basis of age and gender determination in human remains.

2. Methods

We tested the hypothesis of a relationship between the gonial angle values and gender and age of the subjects. This study is in accordance with the tenets of the Declaration of Helsinki and was approved by the institutional review board of the University of Valencia (reference number: H1382425184990). Written informed consent was obtained from all subjects or from their parents when they were under 18 years of age.

2.1. Subjects

A prospective study involving 266 volunteers (110 females and 156 males) was performed between July 2015 and July 2016 in order to ascertain the differences in gonial angle values of Caucasian Mediterranean subjects aged 5–30 years.

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Inclusion criteria comprised Caucasian Mediterranean subjects aged between 5 and 30 years of age, who had no systemic or local pathology, with no disorder at the craniofacial level, and for whom good quality panoramic radiographic studies (orthopantomographies) (i.e. that were well-centered to avoid distortion of any of the structures, that had high image definition, and that did not present overlapping of anatomical details) were available. Exclusion criteria comprised subjects with any local or systemic pathology that could alter the results of the study (for example, patients with congenital anomalies, connective tissue diseases, disorders of a local or general nature that could affect the tooth maturation process or cause tooth disorders regarding number, oligodontia, patients with growth disorders, etc.), patients undergoing orthodontic treatment or having undergone such treatment, patients who had had permanent molars removed, and poor quality panoramic radiographs. To ensure consistency, one investigator was responsible for the selection of radiographs based on the inclusion and exclusion criteria (Leversha et al., 2016).

From an initial sample of 300 orthopantomographies of 300 subjects (100%), 34 (11.3%) were excluded from the study after applying the inclusion and exclusion criteria: one orthopantomography study of a Down Syndrome patient (0.3%), 25 orthopantomographies of subjects with ongoing orthodontic treatment or who had undergone such treatment (8.33%), six orthopantomographies (2.0%) of subjects who had had permanent molars removed, and two orthopantomographies (0.66%) with poor image quality.

Finally, the sample analyzed in the study numbered 266 panoramic radiographs of 266 subjects (266 left and 266 right gonial angles were measured) with an age range from 5 to 30 years (mean ± SD, 17.3 ± 7.4 years) from an initial sample of 300 subjects (88.7%). One hundred and fifty-six were male (58.6%) and 110 female (41.4%). The 266 subjects were subdivided into five age subgroups: 5–10 year-olds (62 subjects with 124 gonial angles measured), 11–15 year-olds (59 subjects with 118 gonial angles measured), 16–20 year-olds (53 subjects with 106 gonial angles measured), 21–25 year-olds (47 subjects with 94 gonial angles measured), and 26–30 year-olds (45 subjects with 90 gonial angles measured).

2.2. Gonial angle measurements

All panoramic radiographs were taken by the same radiographer for standardization purposes (Leversha et al., 2016) and on the same panoramic unit (Cranex Novus®, XMIND Novus® Soredex, France). The mean of five consecutive measurements of each gonial angle was performed by another experienced physician who was unaware of the gender and age of the subjects. Gonial angle measurements were performed by measuring between two tangents from the gonion (Fig. 1); the first running superiorly along the posterior border of the mandibular ramus and the other anteriorly along the inferior border of the body of the mandible (Leversha et al., 2016).

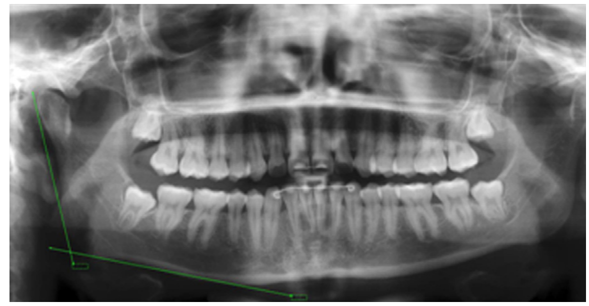

Fig. 1. Measurement of the gonial angle in a digital panoramic radiograph used in this study.

2.3. Statistics

The statistical study was carried out by another physician who did not participate in the selection or gonial angle measurements of the patients. G*Power 3 (version 3.0.10) was used to calculate the statistical power of the current study (Faul et al., 2007). We studied a total sample size of n = 532 gonial angles with 266 subjects included in the study and a value of α error probability = 0.05 (corresponding to α level of 5%); the statistical power reached was 0.76. Normality of the data distribution was determined using the Kolmogorov–Smirnov test. As all quantitative variables were normally distributed, the paired *t*-test and Anova test were used to assess differences between the groups. Pearson's correlation was used to assess a possible relationship between age and the gonial angle values. A *p*-value <0.05 was considered statistically significant. All statistical analyses were performed using SigmaPlot v12 software (Systat Software, Inc., San Jose, CA, USA). Data are reported as mean ± standard deviation (SD).

3. Results

Table 1 presents the gonial angle values obtained in the entire analyzed sample. The differences when analyzing all values beween females and males were not significant, neither were they when comparing the left and right gonial angle values between females and males. Nevertheless, the difference between the left and right gonial angle values were significant within the female and male groups.

Detailed gonial angle values according to age subgroups and gender are presented in Tables 2 and 3. There were statistically significant differences between age subgroups (p < 0.001; Anova test).

Table 1
Gonial angle values obtained in the whole sample analyzed (mean° ± SD).

	n (%)	All	Left	Right	p-Value[a]
Female	220 (41,4%)	122.7 ± 6.7	121.4 ± 7.1	123.9 ± 6.1	0.004[†]
Male	312 (58.6%)	122.8 ± 7.0	121.6 ± 6.8	123.9 ± 7.1	0.006[†]
p-Value[a]	–	0.902	0.851	0.987	–

[†] Statistically significant.
[a] Student's t test.

Table 2
Gonial angle values by age subgroup in all subjects analyzed (mean° ± SD).

	5–10 years	11–15 years	16–20 years	21–25 years	26–30 years
n (%)	124 (23.3%)	118 (22.2%)	106 (19.9%)	94 (17.7%)	90 (16.9%)
Mean ± SD	127.8 ± 4.0	123.4 ± 6.7	121.3 ± 7.1	119.9 ± 6.9	119.3 ± 5.9