Evaluation of the Gonial Angle in the Anatolian Populations: From Past to Present

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ABSTRACT

Biometrical studies on ancient skeletal series and comparison with modern people by using radiological methods are quite limited in Turkey. Previous studies showed that measurements obtained from orthopantomographs are highly correlated with the actual size of the bones. The aim of the present study is to determine the possible change in gonial angle over time in ancient Anatolian populations with the present. Also an aim was attempted to demonstrate the symmetry of the gonial angle in the jaws and the sexual dimorphism. Gonial angle values (right and left) were taken from 267 Turkish adults with no craniomandibular disorders, orthodontic history or treatment by using panoramic radiographs. Data of the past populations were collected from previous studies. Comparison between right and left sides and the sexual differences were tested by paired student t-test and discriminant analyses were conducted. The results showed that there were no significant differences between the right and left gonial angles of the individuals but there was a significant difference at the left gonial angle between sexes (p<0.01). Furthermore, no statistically significant difference was found for the gonial angle between the selected past populations with the present sample.

Key words: mandibula, gonial angle, panoramic radiography, Turkey

Introduction

Paleoanthropological studies performed on skeletal remains provide information on the morphologic structure of individuals from the past. However, biometrical studies subjected present populations are more complex and require specific methods. Panoramic radiographs assist in taking measurements and making evaluations of individuals' jaws and teeth in orthodontics. Various authors have studied the measurement errors of these methods, and they concluded that there were no significant difference between the skeleton and the radiological view[1].

The gonial angle is particularly important in orthodontic research for understanding changes during the developmental period. Orthodontic studies have shown that the directions of the growth of condyls are correlated with gonial angle. Various researchers emphasized that the alteration of gonial angle should be closely monitored by longitudinal studies[2–4]. According to these studies, the gonial angle is very high in children; 130° in fetus and 140° at birth, and it progressively decreases in the growth period. After the completion growth of the deciduous teeth with the appearance of permanent teeth this value decreases to 135°. At adulthood it shows a sudden decrease from 125° to 120°. Studies have also indicated that the angle value of females is 3 to 5 degrees greater than that of males. Gonial angle differences are seen not only during the growth period and between the sexes but also exist among races[5].

From Mesolithic period to up to date various researches studied gonial angle from human skeletal remains from different Anatolian populations. Although former studies' sample number relatively small[6–12], Iznik (Late Byzantine)[13] and Dilkaya (Medieval)[14] populations are larger.

The main aim of the present study is to compare the symmetry of gonial angle and the sexual dimorphism in present sample. In addition an aim was attempted to evaluate the gonial angle difference through time for ancient Anatolian populations.

Materials and Methods

Present study subjected 267 adults (98 males and 169 females) living in Ankara, the capital city of Turkey. Panoramic radiographs were collected from random samples with no craniomandible disorders and no orthodontic treatment in the past. Also special aim was attempted in selection procedure to avoid the cases of cross-bite, over-bite or more than one missing tooth. The mean age of individuals was found to be 23.1 years for males and 22.2 years for females.

The gonial angle values from the present subjects were compared with the skeletal series to investigate possible changes since the Mesolithic period. Skeletal remains from Belbasi Mesolithic site[6], Okuzini Neolithic site[7], Alacahoyuk Chalcolithic Age and Bronze Age sites[8], Muskebi aged BC. 2000[9], Karaoglan Hittite period site[10], Klazomenai Hellenistic site[11], Kocamustafapasa Byzantine site[12], Iznik Late Byzantine site[13] and Dilkaya Medieval site[14] were included in the present study.

Radiographs were taken by using the Trophy Orthopanthomograph OP 100 (Instumentarium, Finland) machine and Kodak films (Eastman Kodak, Rockestie, NY, USA) were used. The radiographs were taken in accordance with the procedures used in the Department of Radiology, Faculty of Dentistry, Gazi University. The bilateral gonial angle measurements were taken directly from the panoramic radiographs. Two lines were drawn on the radiographs between the most posterior point of the condyle and the mandibular angle and the most inferior point of the mandibular angle and the symphysis. To minimize the observer error all measurements were taken by one experienced researcher by using goniometer. In addition various researchers mentioned that accuracy of the gonial angle measurements obtained by using panoramic radiographs are reliable obtained via mandible skeletons[1,15–16]. Taking this point into consideration, the gonial angle degrees were compared from the panoramic radiographs of the present sample and the direct measurements from the human skeletal remains.

Descriptive statistics were calculated and student t-test for equal variances was applied to assess the difference between the sexes and right angle versus left angle within each sex. Also univariate discriminant analysis was used to measure the variation between the sexes. Discriminant analysis is used to classify cases into the values of a categorical dependent. This procedure generates a discriminant function based on linear combinations of the predictor variables that provide the best discrimination between the groups[17]. The data were analyzed by using the Statistical Package for the Social Sciences (SPSS) version 11.0.

Results

The number of the individuals, the mean and standard deviations of the gonial angle according to the sides (left and right) and sexes were given in Table 1. In both left and right sides females showed greater gonial angle

TABLE 1
MEAN AND STANDARD DEVIATIONS OF THE RIGHT AND LEFT GONIAL ANGLE DEGREES

Sex	*Right*			Left	
	n	Mean	SD	Mean	SD
Male	98	122.48	6.95	120.66	7.66
Female	169	123.29	12.87	123.63	6.66

TABLE 2
STUDENT T-TEST RESULTS BETWEEN THE RIGHT AND LEFT GONIAL ANGLE FOR EACH SEX AND BETWEEN SEXES

Sex	t test value between right and left gonial angle degrees for each sex	Side	t-test value between right and left gonial angle degrees by sexes
Male	1.74 NS	Right	0.67 NS
Female	0.31 NS	Left	3.20 *

NS – not significant, * p< 0.01

values. The results of the student t-test for the equality of means for each sex and between sexes were represented in Table 2. The differences in the means of the right and left gonial angle degree were statistically insignificant for both sexes. This shows that there is no asymmetrical difference between the right and left gonial angle degrees of individuals belonging to the same sex. The analysis by sex showed that there was no statistical significance between the right gonial angles. However, the difference between sexes was found to be statistically significant (p<0.01) at left side.

The results of the discriminant analysis which set out the mean value of gonial angle can be seen in Table 3. For each function, the canonical discriminant function coefficients, the sectioning point, the expected accuracy of sex determination was given. In Table 3 functions numbered from 1 to 2 based on single variables were shown. The analyses results showed that the difference between sexes was quite low, ranged from 56.2% to 56.6%. The right gonial angle degree was found to be slightly better single discriminating variable.

TABLE 3
DISCRIMINANT FUNCTION ANALYSIS RESULTS BETWEEN SEXES

Function number	*1*	*2*	*3*
Parameters used	1	1	2
Right Gonial Angle	0.145		–0.028
Left Gonial Angle		0.142	0.162
Constant	–17.899	–17.361	–16.474
Sectioning point	–0.0455	–0.0620	–0.0625
Accuracy (%)	56.6	56.2	59.6
Correct classify (average)	151/267	150/267	59/267

| Population and Period	Author and Publication year	Male		Female	
		n	Mean	n	Mean
Belbasi (Mesolithic)	Bostanci, 1964			1	120.00
Okuzini (Neolithic)	Senyurek, 1958			1	122.00
Alacahoyuk (Chalcolithic)	Kansu and Tunakan, 1946	1	122.00		
Alacahoyuk (Bronze)	Kansu and Tunakan, 1946	1	121.00		
Muskebi (BC. 2000)	Ciner, 1966	1	122.00	1	124.00
Karaoglan (Hittite)	Kansu and Tunakan, 1948	1	125.00		
Klazomenai (Hellenistic)	Gulec, 1989	3	123.30	5	123.00
Kocamustafapasa (Byzantine)	Ciner, 1971			1	125.00
Iznik (Late Byzantine)	Erdal, 1996	115	121.47	21	124.19
Dilkaya (Medieval)	Ozer, 1999	60	123.42	56	124.97
Turkey	Present study	98	120.66	169	123.63
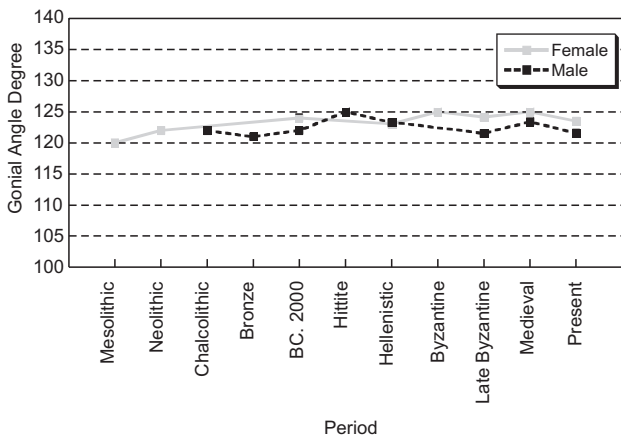
Fig. 1. Comparison of gonial angle degrees in ancient anatolian populations.

Comparison of the present samples gonial angle degrees with former study results were given in Table 4 and Figure 1. According to the results there is a slight increase in the degree compared with Mesolithic and Neolithic periods for females. It is worth to mention that there were no data available for males. In the historical data sexual comparison could be done for Muskebi, Klazomenai, Iznik and Dilkaya populations. Former study results were supporting our results with having higher gonial angle degrees in females than males.

Comparison of Gonial Angle Degrees in Ancient Anatolian Populations

Statistical comparisons were done between ancient skeletal remains and present sample in two populations due to the sample size (Table 5). Iznik and Dilkaya ancient populations and the present sample showed no significant differences for mandibular angle.

Populations	Male	Female
Iznik (Late Byzantine) – Dilkaya (Medieval)	1.82 NS	0.44 NS
Iznik (Late Byzantine) – Turkey (Present)	0.10 NS	0.41 NS
Dilkaya (Medieval) – Turkey (Present)	1.62 NS	1.37 NS

NS – not significant

Discussion

Many studies showed that monitoring gonial angle is important by means of growth in orthodontic researches. Gonial angle degree shows change during growth process and when the growth ceases a slight sexual dimorphism appears with females having higher degrees[18]. In addition it is known that this degree shows variation in between different human populations. From this starting point present study was conducted to determine the gonial angle degree in present Turkish population and to show the possible change through time.

Many authors reported that the gonial angle measurements obtained by using panoramic radiographs are very accurate via directly from skeletal remains[1,15–16]. Therefore we are in the opinion that orthopantomography methods can safely be used for this kind of studies.

The study results present that although in males the right side was larger than the left, there was no statistically significant gonial angle asymmetry was found in both males and females. However, comparison between males and females showed that the female left gonial angle was larger than the males.

The alteration of the gonial angle degrees of ancient Anatolian populations from Mesolithic to up to date was

also investigated. According to the results it can be accorded that in general females have larger gonial angles for all time periods evaluated. But it is difficult to determine whether there is an increase or decrease in gonial angle values from the Mesolithic period to the present due to the lack of samples from different periods and the limited sample available in the historical data. Only the Mesolithic and Neolithic period females showed slight lower degrees but the small sample size and the lack of male data generates difficulty in conclusion. However, statistical comparison showed that there are no significant differences between mean gonial angle degrees between Late Byzantine, Medieval and the present time periods.

In conclusion we are in the opinion that mandibular gonial angle showed sexual dimorphism with having higher values starting from the early settlement times in Anatolia through time. But there is no clear evidence in the change of gonial angle degree in time.

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R E F E R E N C E S

1. CATIC A, CELEBIC A, VALENTIC-PERUZOVIC M, CATOVIC A, JEROLIMOV V, IVANA M, Oral Surg. Oral Med. Oral Pathol. Oral Radiol. Endod., 86 (1998) 242. — 2. RICKETTS RM, Angle Orthod., 27 (1957) 14. — 3. ODEGAARD J, Am. J. Orthod., 57 (1970) 145. — 4. THOMPSON GW, POPOVICH F, Angle Orthod., 44 (1974) 227. — 5. BASS WM, Human Osteology: A Laboratory and Field Manual. (Missouri Archaeological Society, 1995). — 6. BOSTANCI EY, Anthropology, 1 (1964) 17. — 7. SENYUREK MS, Belleten, 22 (1958) 465. — 8. KANSU SA, TUNAKAN S, Belleten, 10 (1946) 539. — 9. CINER R, Anthropology, 1/2 (1966) 1. — 10. KANSU SA, TUNAKAN S, Turkish Historical Congress, IV (1948) 190. — 11. GULEC E, Belleten, 53 (1989) 565. — 12. CINER R, Anthropology, 4 (1971) 171. — 13. ERDAL YS, Anthropological analysis of jaws and teeth of Nicaea late Byzantine population. Ph.D. Thesis. In Turkey (University of Hacettepe, Ankara 1996). — 14. OZER I, The discriminant function analysis of Dilkaya (Van) medieval population and its place among other ancient Anatolian populations. Ph.D. Thesis. In Turkey (Ankara University, Ankara 1999). — 15. MATILLA K, ALTONEN M, HAAVIKKO K, Angle Orthod., 47 (1977) 107. — 16. LARHEIM TA, SVANAES DB, Am. J. Orthod. Dentofac. Orthop., 90 (1986) 45. — 17. MCLACHLAN GJ, Discriminant analysis and statistical pattern recognition. (Wiley-Interscience, Wiley Series in Probability and Statistics, New York, 1992). — 18. SARISOY LT, GUNGOR K, The Journal of Gazi University Faculty of Dentistry 18/3 (2001) 133.

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GONIJALNI KUT U ANATOLIJSKIM POPULACIJAMA OD PROŠLOSTI DO DANAS

S A Ž E T A K

Biometrijska istraživanja provedena upotrebom radioloških metoda na drevnom skeletnom materijalu i usporedba s modernim ljudima, prilično su rijetka u Turskoj. Ranija istraživanja su pokazala kako su mjere dobivene pomoću ortopantomograma vrlo usklađena sa stvarnom veličinom kostiju. Cilj ovog istraživanja je odrediti moguće promjene u gonijalnom kutu koje su se dogodile tijekom vremena od drevnih populacija do današnjih. Cilj je također bio pokazati simetriju gonijalnog kuta čeljusti i spolnog dimorfizma. Vrijednosti gonijalnog kuta (desnog i lijevog) uzete su od 267 odraslih Turaka bez kraniomandibularnih poremećaja, ortodoncijskih zahvata ili zahvata koju su uključivala panoramsku radiografiju. Podaci o populacijama iz prošlosti uzeti su iz ranijih istraživanja. Usporedba lijeve i desne strane i spolne razlike testirane su pomoću studentovog t-test i provedena je diskriminantna analiza. Rezultati su pokazali kako nema značajne razlike između lijevog i desnog gonijalnog kuta kod osoba, međutim postoje velike razlike u lijevom gonijalnom kutu između spolova (p<0.01). Nadalje, nije primijećena statistički značajna razlika gonijalnih kuteva između odabranih populacija iz prošlosti i današnjih populacija.