Original Article

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Gender evaluation in human beings by occlusal radiographs

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Abstract

Aim: To analyze the dental arches by occlusal radiographs for possible gender differentiation. **Methods:** One hundred occlusal radiographic images were obtained. First, a median line and a line touching the vestibular portions of the projections of the maxillary central incisors were drawn. The intersection of these lines was called point I and from this point a line to the canine most vestibular portion was drawn, from the second premolar and second molar, from the left and right sides, in the maxillary and mandibular arches, thus obtaining the angle measurements. Line measurements relative to the width of the arches in three segments, canines, premolars and second molars were made. **Results:** The analyses performed by t-test indicated that all linear values obtained were statistically different ($p<0.05$), as may be seen in the values obtained from canine to canine, in which the female average was 3.48 cm (0.16) while the male average was 3.74 cm (0.21) and in respect to the angle measurements, only two angles have shown applicability in the definition of gender. **Conclusions:** Gender can be determined by analysis of occlusal radiographs with greater reliability when linear measurements are performed.

Keywords: forensic anthropology; forensic dentistry; radiography; gender identify.

Introduction

The need of identifying people not only reflects a social demand; but also follows mainly legal requirements[1]. To give someone an identity is to recognize this person's fulfillment of rights and duties. Therefore, proving someone's identity is not restricted to the legal sphere but also involves civil interests. Human identification can be done by different methods like fingerprint analysis, the most used when soft tissues are preserved. Although situations in which the corpse is charred or skeletonized, an anthropological and dental analysis may be necessary in order to determine the person's identity[2]. It is known that in cases where first the corpses were considered unrecognizable, medical and dental records (radiographs) can assist in a relevant way the human identification processes[3].

However, when human bones are found and the gender needs to be identified, first is taken into consideration the pelvic girdle which gives a great number of qualitative and quantitative data for gender determination, although, in some cases, the coroner has only the skull or just a part of it, which provides some data to assume genders. Therefore, the aim of tis study was to analyze dental arches to verify measures related to gender differentiation, taking into consideration anterior, central and posterior portions by linear and angular measurements.

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Material and methods

The project was approved by the institutional Research Ethics Committee, under the protocol (#0022.0.138.000-10). A total of 50 subjects were selected from a population of 360 dental students, by simple random sampling method. The study group included 25 females (22.12±2.50 years old) and 25 males (21.92±2.58 years old) with an age range of 19-27 years. The subjects were previously informed of all the procedures related to the research and the inclusion criteria were acceptance to participate in the projects' activities, signing of an informed consent form, as well as fitting to the description above. All 50 subjects enrolled in the study had no morphological abnormalities in their teeth and had fully erupted dentition without attrition, caries and were never submitted to dental extractions (except for the third molar in any dental arch), avoiding possible changes in mandibular and maxillary dental arches anatomy.

One hundred occlusal radiographs were taken (Spectro 70X; Dabi Atlante®, Ribeirão Preto, SP, Brazil) following the technique developed by Saliba[4] in order to obtain centralized and standardized radiographic images of anterior teeth up to the second maxillary and mandibular molar. All occlusal radiographs of the maxillary arch were obtained using occlusal type films (Eastman Kodak Co, Rochester, NY, USA), with 1.5 s exposure time and 70 KPV radiation, 40 cm distance between the x-ray source and the x-ray film, with 1.5 s exposure time. In all radiographs, protection rules for the patient were respected, with the use of lead rubber aprons. For the radiographs of maxillary and mandibular arches, the X-ray film was placed in the machine in a way that it was perfectly perpendicular to the main X-ray beams. The patient was told to keep maxillary and mandibular teeth closed, biting the plates of the machine.

After getting the radiographic images[4] the analysis started attributing capital letters to the maxillary arch and small letters to the mandibular arch and the letters L indicating the left side and R indicating the right side, as seen in Figure 1. A median line and a line touching the vestibular portions of the projections of the maxillary central incisors were drawn. The intersection of these points was called point "I". From this point, another line was drawn towards the most vestibular portion of the canine tooth ("C" point), and this line was named linear measure "IC". The angle formed by these two points and "A" point, locating in the line that coincides with the union of the palatal processes of maxillary bone, i.e. medial line, was named "CIA" (Figure 1). Following the same methodology, a line from "I" point to the most vestibular portion of the second pre-molar ("P" point) was drawn, named linear measure "IP". The angle obtained by these two points and "B" point, locating in the line that coincides with the union of the palatal processes of maxillary bone, i.e. medial line, was called "PIB" (Figure 1). At last, the line starting from "I", following until the second molar vestibular side most prominent radiograph projection ("M" point) was named "IM". The angle obtained by these two points and "C" point, locating in the line that coincides with the union of the palatal processes of maxillary bone, i.e. medial line, was named "MIC" (Figure 1). Then the same drawings were made in the mandibular arch, following the same sequence but naming the abbreviations in low case letters, so the angle measures became "cia", "pib", "mic" and linear measures became "ic", "ip" and "im".

Measures related to the maxillary and mandibular dental arches width were made in three portions (Figure 2): (I) Canine portion, linear measure "CC" (maxillary arch) and "cc" (mandibular arch), corresponding to a line drawn from the most vestibular portions of the left and right canines' radiograph projections; (II) Premolars portion, linear measure "PP" (maxillary arch) and "pp" (mandibular arch), corresponding to a line drawn from the most vestibular portions of left and right second premolars radiographic projections; (III) Second molars portion, linear measure "MM" (maxillary arch) and "mm" (mandibular arch), corresponding to a line drawn from the most vestibular

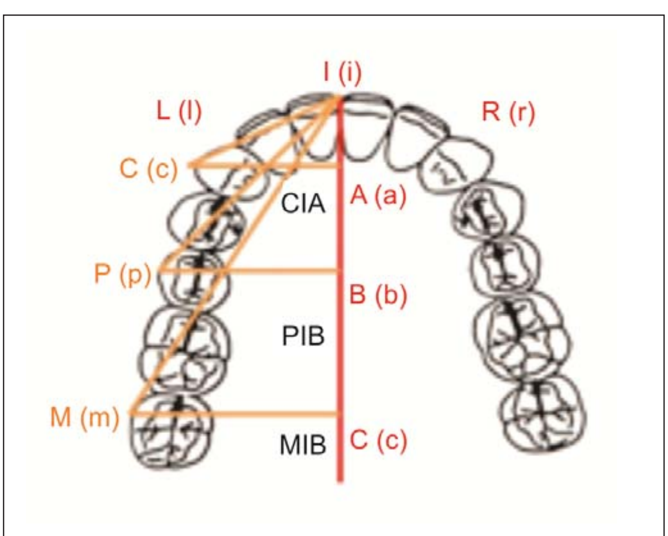

Fig. 1 – Schematic illustration. Angular measurements.

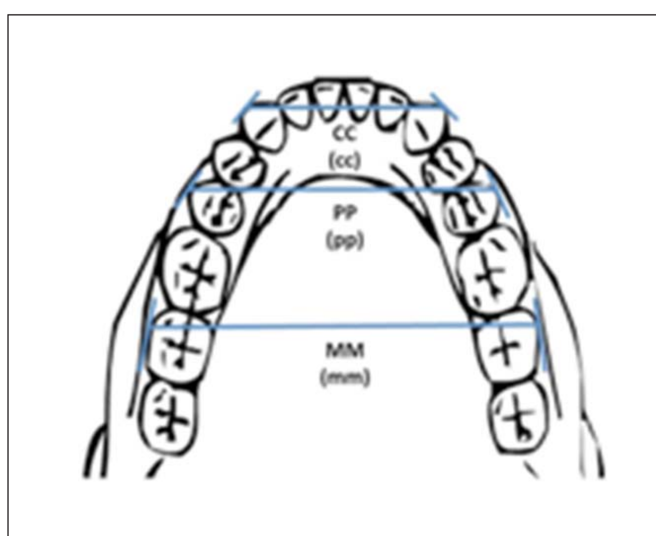

Fig. 2 – Schematic illustration. Linear measurements.

Table 1 – Means and standard deviations of angular measurements, male and female, Ribeirão Preto, Brazil.

	"CIA"R	"PIB"R	"MIC"R	"CIA"L	"PIB"L	"MIC"L	"cia"r	"pib"r	"mic"r	"cia"l	"pib"l	"mic"l
Male												
Mean	32.68	59.16	77.72	34.44	59.44	78.52	17.92	49.80	74.28	22.12	52.48	75.76
SD	5.07	4.29	2.76	5.25	3.83	2.98	6.42	5.68	3.54	6.59	4.49	3.45
Female												
Mean	32.20	59.48	77.50	31.90	59.18	76.40	20.56	49.24	73.72	27.64	54.40	76.88
SD	5.38	4.79	4.04	4.75	5.08	3.32	7.00	7.54	3.91	6.15	5.33	3.30

portions of left and right second molar radiographic projections.

Experimental data were statistically analyzed by ANOVA, since data distribution was normal, to check gender influence in human identification. T test ($p<0.05$) was used as comparison basis. Statistical analysis was made with the software SPSS for Windows, version 12.0 (SPSS Inc., Chicago, IL, USA).

Results

Means and standard deviations obtained for male and female research subjects can be seen in Tables 1 and 2. Linear variables analyzed by t-test were statistically significant ($p<0.05$) for gender differentiation, while angular values have shown statistical differences ($p<0.05$) between male and female only in "MIC"L and "CIA"l angle measures.

Discussion

A human identification process must attend biological demands like oneness and immutability of analyzed characteristics and technical requirements such as classification and practicability of these findings[5]. Based in these requirements, fingerprinting is the most used human identification technique around the world, although in situations where the corpses have significant changes or soft tissues destruction, Anthropology and Forensic Dentistry[5] can be used together, giving more reliable results. DNA is also is commonly used as well, with excellent results, but depends specifically on structure and human resources.

In an anthropological analysis the coroner uses statistical parameters, associating qualitative and quantitative characteristics to a determined populational group, mainly in the attempt of estimating data like: species, gender, ethnical group, age, height and weight[6], searching the establishment of general characteristics for a general identification, since in these cases there are no data before the person's death[7].

Gender estimation must be the first item to be stabilished in an identification and the skull is the focus regarding gender differentiation by morphological aspects observation or qualitative and metric or quantitative[8]. Most studies on gender differentiation in human skulls refer to qualitative variables as glabella characteristics, bone surface and muscle inserts[9], superciliary arches[10] and frontonasal joint[2]. However, not always skulls from male subjects show standardized characteristics, having some similarities with female skulls, which provide unreliable results[8] and population differences[11].

As for the quantitative variables, different measures between pre-set points were studied by many authors, specially through skull radiographs in order to identify gender differentiation[1,12-13], knowing that the skull isolated from the skeleton offers major difficulties in the identification process. It is valuable to highlight that differences between genders are not always perceptible, since there are features that overlap both genders. Additionally, gender dimorphism does not express itself equally between individuals, it goes through morphological influences from the ethnic group, cultural habits and age[14].

Recenetly, gender dimorphism has been studied with metric parameters and has the advantage of distinguishing gender dimorphism among different populations, with reliable results[14]. This is the goal of this research, that by linear and angular measures obtained from occlusal radiographs, was noticed a statistical difference between males and females, especially related to linear measures, demonstrating to be possible non-identified corpse gender identification with this analysis.

Gender dimorphism is the system to identify differences in shapes of men and women. In addition, gender identification allows the elimination of half the population, leading to a more precise search of the dead person's identity[14].

Some authors have used linear measures to determine gender, especially through craniometric measurements[15], but there are few researches relating the size and shape of dental arches. Merz[16] studying the size of dental arches did not find significant differences between genders, which disagrees with this research. Therefore the synergism of teeth size effect together with the arch shape may contribute to the differences between the studied groups, since Caucasian women usually have smaller teeth and African descent males have the biggest teeth in the dental arches[17]. Based in these data, relationship

Table 2 – Means and standard deviation of linear measurements, male and female, Ribeirão Preto, Brazil.

	CC	PP	MM	cc	pp	mm
Male						
Mean	3.7400	5.1840	6.3920	3.0480	4.6880	6.2000
SD	0.21409	0.28089	0.23615	0.19391	0.23695	0.20817
Female						
Mean	3.4880	4.8840	5.9320	2.8400	4.4280	5.8080
SD	0.16912	0.27031	0.39021	0.13540	0.24752	0.31744

between arch size can vary among gender and ethnical group, indicating bigger sizes in males, as seen in the present study of linear measures. Therefore, as demonstrated by Dalidjan et al.[18], discordance and a slight relationship between teeth size and arches shape can be observed.

There are many things that influence the size of teeth and the shape of arches. Dentofacial complex relationship, the tissue that involves them, occlusion, just as dental arches variability in shape and genetic component are related to the differences found in the maxilla and mandible[18]. Coronal morphology and permanent teeth sizes are unchanged during growth and development process, except for specific conditions of nutritional abnormality or disorders inherited in other pathological conditions. Thus, odontometry can be used in gender determination. Finally, this is a simple, quick and accurate technique for gender determination, which is always population-specific, allowing gender determination through occlusal radiographs, highlighting the obtained linear values.

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References

1. Borges SR. Sexual dimorphic characteristics. Quantitative variations in facial areas and distances, by means of lateral cephalometric radiographs in white adult. Rev Bras Odontol. 1977; 31: 118-27.
2. Gupta A, Kumar K, Shetty DC, Wadhwan V, Jain A, Khanna KS. Stature and gender determination and their correlation using odontometry and skull anthropometry. J Forensic Dent Sci. 2014; 6: 101-6.
3. Kirk NJ, Wood RE, Goldstein M. Skeletal identification using the frontal sinus region: a retrospective study of 39 cases. J Forensic Sci. 2002; 47: 318-23.
4. Daruge E, Nouer DF, Saliba TA. The study of linear and angular measures of is dental superior and inferior arches and pericial important. Braz Dent J. 2000; 79: 1136-9.
5. Robinson MS, Bidmos MA. The skull and humerus in the determination of sex: reliability of discriminant function equations. Forensic Sci Int. 2009; 186: 86-95.
6. Panchbhai AS. Dental radiographic indicators, a key to age estimation. Dentomaxillofac Radiol. 2011; 40: 199-212.
7. Passalacqua NV. Forensic age-at-death estimation from the human sacrum. J Forensic Sci. 2009; 54: 255-62.
8. Jaja BN, Ajua CO, Didia BC. Mastoid triangle for sex determination in adult nigerian population: a validation study. J Forensic Sci. 2013; 58: 1575-8.
9. Celbis O1, Iscan MY, Soysal Z, Cagdir S. Sexual diagnosis of the glabellar region. Leg Med. 2001; 3: 162-70.
10. Garvin HM, Sholts SB, Mosca LA. Sexual dimorphism in human cranial trait scores: effects of population, age, and body size. Am J Phys Anthropol. 2014; 154: 259-69.
11. Lopez MC, Galdames ICS, Matamala DAZ, Smith RL. Sexual Dimorphism Determination by Piriform Aperture Morphometric Analysis in Brazilian Human Skulls. Int J Morphol. 2009; 27: 327-31.
12. Naikmasur VG, Shrivastava R, Mutalik S. Determination of sex in South Indians and immigrant Tibetans from cephalometric analysis and discriminant functions. Forensic Sci Int. 2010; 197: 122.e1-6.
13. Ghoubril JV, Abou Obeid FM. Three-dimensional facial architecture in normodivergent class I Caucasian subjects. Odontostomatol Trop. 2013; 36: 5-14.
14. Camps FE. Gradwohl's legal medicine. 3rd ed. Wright and Son: Bristol John; 1976.
15. Nascimento Correia Lima N, Fortes de Oliveira O, Sassi C, Picapedra A, Francesquini L Jr, Daruge E Jr. Sex determination by linear measurements of palatal bones and skull base. J Forensic Odontostomatol. 2012; 30: 38-44.
16. Merz M. Tooth diameters and arch perimeters in a black and white population. Am J Orthod Dentofac Orthop. 1991; 100: 53-8.
17. Altherr ER, Koroluk LD, Phillips C. Influence of sex and ethnic tooth-size differences on mixed-dentition space analysis. Am J Orthod Dentofacial Orthop. 2007; 132: 332-9.
18. Dalidjan M, Sampson W, Townsend G. Prediction of dental arch development: an assessment of Pont's Index in three human populations. Am J Orthod Dentofacial Orthop. 1995; 107: 465-75.