

Sex Determination in Mandibles in the First Year of Life by a Quantitative Approach

Determinación del Sexo en Mandíbulas en el Primer Año de Vida Mediante una Aproximación Cuantitativa

***Iván Claudio Suazo Galdames; **Daniela Alejandra Zavando Matamala & **Ricardo Luiz Smith

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SUMMARY: Numerous studies have shown that skeletal characteristics vary among different populations. Several authors suggest that it is possible to determine sex through the anatomical evaluation of children mandible, however there are few morphometrical studies conducted with such specimens. The purpose of this study was to analyze several mandibular dimensions and identify the ones that could be useful to perform sex differentiation in a sample of Brazilian young children. For this study we used 32 children dry mandibles of known sex, age ranging from 0 to 1 year old. The mandibles pertain to the collection of the Skull Museum of the Universidade Federal de São Paulo (UNIFESP). The parameters included bicondilar width, bigonial width, minimum width and height of the mandibular ramus, gonion-gnation length, height of the mandibular symphysis and transverse and anteroposterior condylar dimensions. The SPSS program was used to carry on the discriminant function analysis and the T test ($p < 0.05$). There were no statistically significant differences that could allow identification of a specific parameter for sex determination. However, most of the dimensions were higher in male than in female, except for the minimum width of the mandibular ramus (0.2-0.16 mm) and transverse diameter of the right condyle (0.16mm). The values obtained for the anteroposterior diameter of the mandibular head were the most different between genders, although no statistical significance was found. Discriminant function analysis indicated that, despite differences, none of the evaluated parameters allow for sex classification with enough reliability. In conclusion, there is little sexual dimorphism in children's mandibles during the first year of life and anatomical analysis of this structure is not recommended as reliable quantitative approach for sex differentiation with forensic purposes.

KEY WORDS: Sexual Dimorphism; Sex determination; Infants; Mandibles.

INTRODUCTION

The difficulty to determine sex of individuals in children bone remnants is a known problem that limits the anthropological investigations and forensic practice. Several methods have been described for sex diagnosis from postcranial skeleton, particularly the hip bone.

Merrot *et al.* (2001) used 500 x-ray images of the pelvis of stillborn fetuses and determined that the interischiatric tuberosity distance was a good indicator of sexual dimorphism from 26 week of intra-uterine life. In another study Holcomb & Konigsberg (1995) analyzed the greater ischiatic notch of human term fetuses and found sexual dimorphism in shape, but not in dimensions, so the usage of the quantitative parameter was questioned as an indicator of sex in fetuses. In contrast, Schutkowski (1993) has reported that men exhibited a greater ischiatic notch closer and deeper

than women. These indicators, along with the more prominent chin and the width of dental arch allow to correctly classify 70-90% subjects between 0 and 5 years old.

The mesiodistal and bucolingual crown dimensions of teeth have also been studied for sex determination in subadults individuals. Cardoso (2008) indicates that, for both adult and subadults, the canines are the pieces that have greater sexual dimorphism. For Rösing (1983), the teeth are only one of the elements that are developed with the adult size and that his dimorphic morphological character is maintained over time.

The mandible also seems to be useful for sex classification in immature skeletons. Loth & Hennenberg (2001) described a simple, qualitative method for sex

* Departamento de Anatomía Normal, Universidad de Talca, Chile

** Departamento de Morfología y Genética, Universidade Federal de São Paulo, Brasil.

differentiation in subadults' mandibles through shape analysis of the mandibular body with 81% accuracy. These results were discussed by Coqueugniot *et al.* (2002), who performed a similar study obtaining lower accuracy levels. Subsequently, Suazo *et al.* (2008a) developed a study with a sample of Brazilian mandibles and reported accuracy levels between 57.5 and 60.5% for sex determination, with greater sensitivity for determining male, and conclude that it is necessary to carefully evaluate the methods of sex determination from subadults mandibles in specific populations.

Considering this background, the goal of this study is to determine several dimensions of mandibles in a sample of Brazilian children in the first year of life and analyze the reliability of these parameters in sex determination with forensic purposes.

MATERIAL AND METHOD

We used 32 mandibles of Brazilian children between 0 and 1 year-old, 20 males and 12 females. The mandibles belong to the Skull Museum collection of the Morphology and Genetics Department, Universidade Federal de São Paulo (UNIFESP), Brasil.

The mandibles were separated from the skull, without morphological alterations and no evidence of trauma. Using a digital caliper (0.01mm) the following measurements were taken:

- Bicondilar width: Distance between the lateral poles of the right and left mandibular head.
- Bigonial width: Distance between the right and left mandibular angle.
- Minimum width of the mandibular ramus: Minimum distance between the anterior and posterior edge of the mandibular ramus.
- Height of the mandibular ramus: distance between the deepest point of the mandibular incisure and the deepest part of the antegonial incisure, is measured in the right and left mandibular ramus.
- Gonion-gnation length: Distance between the mandibular angle and the lowest point of the mandible in the anterior median line. It is measured from the right and left mandibular angle.
- Height of the mandible: Maximum length of the mandibular median line.
- Transverse dimension of the mandibular head: Distance between lateral pole and medial pole of the mandibular head. It is measured on the right and left side.
- Anteroposterior dimension of the mandibular head: maximum distance between the anterior and posterior face of the mandibular head, measured at right and left sides.

For some mandibles, difficult or doubtful measurements were excluded and only the data obtained were submitted to the t test for independent samples, $p < 0.05$ and discriminant function analysis with SPSS 15.0.

RESULTS

The twelve linear dimensions were analyzed in a sample of 32 mandibles. Due to advanced erosion in one of the mandibles, it was not possible to obtain the measurement of the left mandibular ramus minimum width. In other three male mandibles it was not possible to determine the maximum anteroposterior diameter and the maximum transverse mandibular head.

Most of the measured dimensions were greater in male, except for the minimum width of the left and right mandibular ramus and maximum transverse diameter of the right mandibular. However, none of the differences was statistically significant, meaning that the discriminant analysis procedure was negative. This is verified by the high values of the Lambda Wilks statistics.

The analyzed parameters and statistic analysis are shown in Table I.

DISCUSSION

To determine the gender of immature skeletons, hip, mandible and teeth seem to be the most useful elements.

The dimorphic traits in children's mandibles, described by Loth & Henneberg, allow the correct classification of a large number of cases, but are likely to present a population-specific behavior, which may explain the lower accuracy of subsequent studies.

On the other hand, the literature generally assumes that the objective assessment of the skeletal remnants through metric comparisons allows us to obtain better statistical standards of accuracy for age determination and sex diagnosis in forensic and anthropological sciences.

The present study analyzed a series of linear dimensions in children's mandibles and concluded that, despite certain differences, no precise dimorphism could be verified concerning mandible size in the analyzed sample. These findings are consistent with those reported by Franklin *et al.* (2007), who have used geometric morphometry method

Table I. Descriptive statistics, and p value of Wilks' lambda of the linear dimensions analyzed in 32 mandibles of children aged between 0 and 1 year old of the collection of UNIFESP.

	Sex	n	Mean	SD	Sig.	Wilks' lambda
• B icondilar width	Male	20	63.1350	6.92755	.998	.999
	Female	12	63.1275	8.27786		
• B igonial width	Male	20	50.4790	6.83989	.584	.994
	Female	12	49.1158	6.57738		
• H eight of the righth mandibular ramus	Male	20	19.2510	3.96959	.460	.978
	Female	12	18.2325	3.26029		
• H eight of the left mandibular ramus	Male	20	18.8530	3.84045	.547	.990
	Female	12	18.0408	3.28720		
• M inimum width of the righth mandibular ramus	Male	19	16.9611	2.38965	.819	.996
	Female	12	17.1700	2.56457		
• M inimum width of the left mandibular ramus	Male	19	17.1247	2.31920	.846	.998
	Female	12	17.2933	2.35827		
• R ight gonion-gnation	Male	20	40.1245	5.37346	.440	.986
	Female	12	38.5642	5.60068		
• L eft gonion-gnation	Male	20	38.9930	5.37810	.709	.997
	Female	12	38.2550	5.33035		
• T ransverse dimension of the righth mandibular head	Male	19	9.0995	1.46108	.757	.993
	Female	12	9.2633	1.34999		
• T ransverse dimension of the left mandibular head	Male	20	9.2180	1.60052	.689	.999
	Female	12	9.0008	1.21001		
• A nteroposterior dimension of the righth mandibular head	Male	18	5.4917	.77062	.866	.999
	Female	12	5.4425	.77879		
• A nteroposterior dimension of the left mandibular head	Male	19	5.8226	.74800	.323	.973
	Female	12	5.5325	.83567		
• H eight of the mandible	Male	20	13.678	2.6423	.482	.990
	Female	12	12.991	2.6479		

on 38 landmarks and have concluded that no sexual dimorphism can be determined in subadults mandibles.

Much higher accuracy indexes (70-90% accuracy) were obtained by Schutkowski, who has conducted a combined metric analysis from different parts of the skeleton, including the mandible. However, whenever the skeleton remains are not complete and assessment must be made from the mandible only, our results recommend the use of a non-metric or qualitative analysis for the diagnosis of sex in subadults, this is also applied when specific populations' skeletal remainders exist or in those that one suspects of nutritional alterations (Suazo *et al.*, 2008b, 2008c).

In conclusion, mandibles in the first year of life present little sexual dimorphism and is a quantitative approach seems not to be the best tool for sex identification with forensic purposes.

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RESUMEN: Numerosos estudios han demostrado que las características esqueléticas varían en las distintas poblaciones. Diversos autores indican que es posible la determinación del sexo en base a mandíbulas infantiles; sin embargo, existen escasos estudios morfométricos realizados en mandíbulas de niños brasileiros. El propósito de este estudio fue analizar distintas dimensiones de mandíbulas y determinar aquellas de utilidad en el diagnóstico forense del sexo, en población infantil brasileira. Se utilizaron 32 mandíbulas de niños brasileiros de entre 0 y 1 año de edad, de sexo conocido, pertenecientes a la colección de cráneos de la Universidade Federal de São Paulo (UNIFESP). Las mediciones mandibulares incluyeron ancho bicondilar, ancho bigonial, ancho mínimo y altura de la rama mandibular, longitud gonion-gnation, altura de la sínfisis mandibular y las dimensiones transversa y anteroposterior del cóndilo. Los datos obtenidos fueron sometidos

al t test ($p < 0,05$) y análisis de la función discriminante con SPSS. La mayoría de las dimensiones fueron superiores en hombres que en mujeres, con excepción del ancho mínimo de la rama mandibular (0,2-0,16 mm) y del diámetro transversal del cóndilo derecho (0,16 mm). El diámetro anteroposterior de la cabeza mandibular resultó la más dimórfica de las medidas analizadas, aunque ninguna diferencia resultó estadísticamente significativa. El análisis de la función discriminante indicó que a pesar de las diferencias, éstas no permiten clasificar de acuerdo al sexo, en base a las variables cuantitativas analizadas. En conclusión, la mandíbula de niño en el primer año de vida presenta escaso dimorfismo sexual y no se recomienda el abordaje cuantitativo para la determinación del sexo con fines forenses.

PALABRAS CLAVE: Dimorfismo sexual; Determinación del sexo; Subadultos; Mandíbula.

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Correspondence to:
Prof. Dr. Iván Suazo Galdames
Departamento de Anatomía Normal
Universidad de Talca
Avenida Lircay s/n. Oficina N°104
Talca - CHILE

Email: isuazo@utalca.cl

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