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Sex determination using the mesio-distal dimension of permanent maxillary incisors and canines in a modern Chilean population

Tanya R. Peckmann [a,*], Ciara Logar [b], Claudia E. Garrido-Varas [c], Susan Meek [d], Ximena Toledo Pinto [e]

[a] Forensic Sciences Program, Department of Anthropology, Saint Mary's University, Halifax, NS B3H 3C3, Canada
[b] Forensic Sciences Program, Saint Mary's University, Halifax, NS B3H 3C3, Canada
[c] International Committee of the Red Cross, 19 Av de la Paix, Geneva, Switzerland
[d] Department of Biology, Saint Mary's University, Halifax, NS B3H 3C3, Canada
[e] School of Dentistry, University of Chile, Sergio Livingstone 943, Independencia, Santiago, Chile

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ABSTRACT

The pelvis and skull have been shown to be the most accurate skeletal elements for the determination of sex. Incomplete or fragmentary bones are frequently found at forensic sites however teeth are often recovered in forensic cases due to their postmortem longevity. The goal of the present research was to investigate sexual dimorphism between the mesio-distal dimension of the permanent maxillary incisors and canines for the determination of sex in a contemporary Chilean population. Three hundred and three dental models (126 males and 177 females) from individuals ranging in age from 13 years to 37 years old were used from the School of Dentistry, University of Chile. The statistical analyses showed that only the central incisors and canines were sexually dimorphic. Discriminant function score equations were generated for use in sex determination. The average accuracy of sex classification ranged from 59.7% to 65.0% for the univariate analysis and 60.1% to 66.7% for the multivariate analysis. Comparisons to other populations were made. Overall, the accuracies ranged from 54.4% to 63.3% with males most often identified correctly and females most often misidentified. The determination of sex from the mesio-distal width of incisors and canines in Chilean populations does not adhere to the Mohan and Daubert criteria and therefore would not be presented as evidence in court.

1. Introduction

Between 1973 and 1990 General Augusto Pinochet led a dictatorship in Chile. The Pinochet regime implemented the systematic practice of forced disappearances and extrajudicial killings [1]. A total of 3227 individuals have been declared missing with 1465 of these individuals identified as cases of detenidos-desaparecidos, or enforced disappearances [2]. The transition to democracy in Chile needs to include locating and identifying these individuals [3].

When identifying human remains, the determination of sex is of primary significance as the determination of stature and age at death is sex dependent. The pelvis and skull have been shown to be the most accurate skeletal elements for the determination of sex [4–7]. However, incomplete or fragmentary bones are frequently found at forensic sites due to postmortem damage and taphonomic changes.

Teeth are often recovered in forensic cases due to their postmortem longevity as they are highly resistant to physical and chemical influences. Teeth are the hardest and most durable material in the human body. They are more resilient than bone and are often the only human material recovered in mass disasters. Dentition offers vast amounts of information for the forensic anthropologist and odontologist. They can provide an estimation of sex, age, diet, and geographic origin for the unknown individual [8–10]. Research has shown that tooth crown diameters are clinical markers for sex differentiation [11–31].

The mesio-distal dimension of permanent teeth has been studied, for determination of sex, in populations from Southern China [11], Saudi Arabia [12,13], Japan [14], Turkey [15], Nigeria and Britain [16], India [17–23], the Philippines [24,25], Sweden [26], Brazil [27], Nepal [28,29], Greece [30], and White Americans [31]. The permanent maxillary and mandibular incisors and canines are advantageous for sex estimation as they are the least frequently extracted teeth and are less often affected by periodontal disease [32–34]. Research has shown that estimation of sex from the mesio-distal dimension of maxillary incisors and canines is population specific [11–31]. The accuracy rates for mesio-distal dimensions of maxillary incisors and canines for sex estimation in a contemporary Chilean population have not been investigated to date. This research will therefore assist in the identification of unknown individuals of Chilean ancestry.

The goals of this research are to (1) investigate sexual dimorphism between the mesio-distal dimension of the permanent maxillary

* Corresponding author at: Saint Mary's University, Forensic Sciences Program, 923 Robie Street, Halifax, Nova Scotia B3H 3C3, Canada. Tel.: +1 902 496 8719.
E-mail addresses: tanya.peckmann@smu.ca (T.R. Peckmann), ciara.j.logar@gmail.com (C. Logar), dragarrido1@gmail.com (C.E. Garrido-Varas), susan.meek@smu.ca (S. Meek), xitol@hotmail.com (X.T. Pinto).

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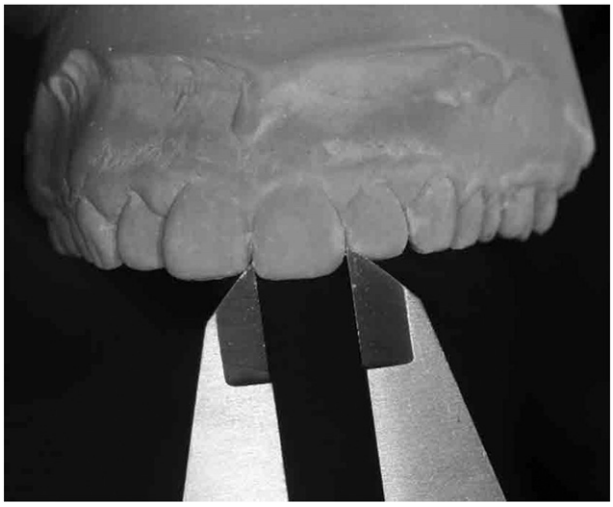

Fig. 1. Mesio-distal measurement of the central incisor.

incisors and canines, and (2) test the accuracy of the mesio-distal dimension of the permanent maxillary incisors and canines for the determination of sex in a contemporary Chilean population.

2. Materials and methods

This research utilized 303 dental models (126 males and 177 females) from the Instituto Nacional de Ortodoncia, Chile. The individuals ranged in age from 13 years to 37 years old and had birth dates from 1970 to 2000 and therefore this sample represents a contemporary Chilean population. On becoming a patient at this clinic, each person is required to sign a consent form for use of their models for research. Age and sex demographics about each individual are known.

The greatest mesio-distal dimension of the permanent left and right maxillary incisors and canines was measured. The mesio-distal dimension is defined as the maximum distance between the most mesial and the most distal point of the crown (Figs. 1 and 2).

The teeth utilized included:

Tooth 1.1 — Right central incisor
Tooth 1.2 — Right lateral incisor
Tooth 1.3 — Right canine
Tooth 2.1 — Left central incisor
Tooth 2.2 — Left lateral incisor
Tooth 2.3 — Left canine

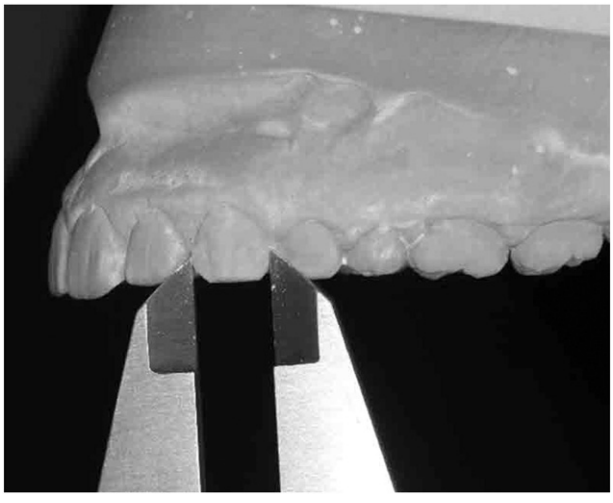

Fig. 2. Mesio-distal measurement of the canine.

Table 1
Descriptive statistics for the Chilean population.

Tooth	Males			Females			Overall
	n	Mean (mm)	Standard deviation (mm)	n	Mean (mm)	Standard deviation (mm)	% Sexual dimorphism[a]
1.3	126	8.367	0.482	177	7.977	0.482	4.89
1.2	126	7.014	0.531	177	6.960	0.615	0.76
1.1	126	8.819	0.529	177	8.606	0.510	2.48
2.1	126	8.953	0.465	177	8.696	0.492	2.96
2.2	126	7.149	0.498	177	7.020	0.589	1.84
2.3	126	8.363	0.431	177	7.969	0.565	4.94

[a] % Sexual Dimorphism: [(male mean − female mean)/female mean] × 100.

All metric values were collected by one observer with a digital vernier caliper and measured to the nearest 0.0 l mm. Criteria for inclusion included fully erupted permanent maxillary incisors and canines that were peridontally healthy with normal occlusion and no spacing, crowding, attrition, caries, dental fillings, history or clinical evidence of crown restoration, orthodontic treatment, or trauma. This protocol follows that of other researchers [11,13–16,19,25,26]. Intra- and inter-observer error rates were calculated by re-measuring 20 randomly selected individuals (10 males and 10 females). The measurements between observers were collected one week a part.

Statistical analyses were performed with the SPSS (version 21.0) software program using a Bonferroni-adjusted level of significance. Normality and independent *t*-tests were conducted using Minitab (version 17). Descriptive statistics were obtained for each measurement (Table 1). Males and females were analyzed separately. Using a two sample *t*-test the mean values of the measurements were compared between the sexes to determine if statistically significant differences existed. The variables were subjected to direct and stepwise discriminant function analyses. The Chilean teeth measurements were compared with other populations, separately two by two, using two sample *t*-tests: Northern India [18,21], Brazil [27], Nepal [29], Iraq [28], Saudia Arabia [12], and Southern India [17]. Although raw data was unavailable for the comparative populations, Minitab allows the use of summarized data (e.g. sample size, mean, standard deviation) from two samples to conduct a two-sample *t*-test. A paired *t*-test was used to calculate the intra- and inter-observer error rates for each measurement variable. Each variable of the incisors and canines was re-measured from each of the 20 individuals, i.e. all variables were measured three times: original data, intra-observer data, inter-observer data. Paired *t*-tests were then carried out on each variable comparing the difference between the original and re-measured values.

All data were tested for normality and all variables were normally distributed using a Bonferroni-adjusted level of significance $p < 0.004$; males and females were tested separately and all ages combined. As

Table 2
Intra- and inter-observer error rates for the Chilean population.

Tooth	*n*	Mean difference (mm)	*t*-value	p-value
Intra-observer error				
1.3	20	−0.007	−0.180	0.859
1.2	20	0.080	−1.170	0.273
1.1	20	−0.087	−2.130	0.062
2.1	20	−0.093	−2.080	0.067
2.2	20	0.290	1.080	0.307
2.3	20	0.090	1.350	0.211
Inter-observer error				
1.3	20	0.194	2.45	0.037
1.2	20	0.231	3.31	0.009
1.1	20	0.140	1.45	0.182
2.1	20	0.104	1.22	0.254
2.2	20	0.326	1.20	0.260
2.3	20	0.272	3.16	0.012

*$p < 0.008$; Bonferroni correction.