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Sexual dimorphism in deciduous crown traits of a European derived Australian sample

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ABSTRACT

Sex determination of juvenile skeletal remains is a problematic area affecting physical anthropology, forensic science and archaeology. Sexual dimorphism in the morphometric crown traits of the deciduous dentition may be used to help resolve this issue. Dental stone casts from a European derived Australian sample ($n = 151$) were used to investigate variation within crown traits of the deciduous canine and molars. The metric traits investigated were crown size, trigonid size and talonid size. The morphological features included Carabelli's trait and molar cusp number. Metric crown traits were significantly larger in males ($p < 0.05$). The morphological crown traits were not significantly different between the sexes. The largest degree of sexual dimorphism was 11.11% in the trigonid mesiodistal diameter of the first deciduous molar. This is the first recording of the measurement in a European derived sample. Two multivariate statistics, linear functional discriminant analysis and binary logistic regression, were used to determine the success rate of sex classification from the crown traits. The most suitable was linear functional discriminant analysis, however similar results were found when using binary logistic regression. When using all variables investigated in this study, sex could be classified with accuracy of 70.2% from linear functional discriminant analysis (cross validated). The mandibular teeth had greater sexual dimorphism, classifying sex correctly 74.8% of the time compared to maxillary variables that had a success rate of 55.6%. Our results have shown that morphometric crown traits in the deciduous dentition can be used to classify sex of juvenile skeletons (11 months to 12 years) of European descent from linear functional discriminant analysis with accuracy between 70.2% and 74.8%.

1. Introduction

Sexual dimorphism in the tooth crown is of interest to physical anthropologists, having implications for forensic and archaeological studies where it is used to assist in identification of skeletonized remains [1]. The determination of sex of juvenile skeletons, is one of the most problematic observations in identification [2–4]. Investigations of sexual dimorphism in the juvenile skeleton have not revealed replicable significant sex differences [2–8]. If sexual dimorphism exists in the deciduous dentition, it could be used to determine the sex of individuals between 11 months and 12 years, when the completely formed deciduous crowns are present in the tooth crypts or oral cavity [9,10].

1.1. Overall crown size

Traditionally the study of sexual dimorphism in the dentition has been associated with metric traits, such as overall crown size, favored because of their objectivity and reliability, and observed sex differences in the permanent dentition [11–14]. Crown size is approximated from two measurements, maximum crown length (mesiodistal diameter) and breadth (buccolingual diameter) [15]. Males display larger crowns than females due to the growth promoting effect of the Y chromosome on dentinogenesis (production of dentine) that results in thicker dentine, producing larger teeth [16,17]. Sexual dimorphism has been observed in the deciduous dentition, with distinctions in the degree noted between populations [13,14,18]. The highest recording of sexual dimorphism was in a European derived group from Burlington, United States of America at 4% [19], followed by African Americans at 3.0% [20–22], Australian Aboriginals at 2.5% [20] and Chinese Taiwanese at 1.1% [23,24]. Sexual dimorphism in the above studies was significantly different with the exception of the Chinese sample [24,25]. This study used mesiodistal diameter only to approximate

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crown size, which is more variable and less dimorphic than buccolingual diameter [19,53].

There are issues with using crown size. It is effectively a one-dimensional variable as mesiodistal and buccolingual diameters are positively intercorrelated [26–28]. The inability of the crown size measurement to reflect the complex nature of the crown highlights the need to investigate alternative crown traits, which will capture information evaded by crown size alone and may prove to be good diagnostic tools for sex identification.

1.2. Trigonid and talonid cusp size

The trigonid and talonid are the mesial and distal portions of the mandibular molars, respectively [29,30] (Fig. 1). The few studies of sexual dimorphism in the size of the trigonid and talonid in the deciduous dentition have shown greater differences than crown size. The talonid has been found to be 7.15% larger in males than females in studies of Australian Aboriginals [31] and Taiwanese Chinese [29,31]. The higher sexual dimorphism in the talonid compared to the trigonid has been attributed to its later development than the trigonid, resulting in greater exposure of the talonid to hormones during development [31]. It is unknown whether the trigonid and talonid are intercorrelated as crown size is. However, as the trigonid and talonid measurements do not overlap, redundancy is minimized and the measurements are more likely to reflect the complex cuspal crown structure.

1.3. Carabelli's trait

Carabelli's trait is an additional cusp or groove on the mesiolingual surface of the maxillary first permanent molar or second deciduous molar (Fig. 2). It has been found to be sexually dimorphic in the permanent dentition, with males displaying the cuspal form and females an absence or groove shape [32,33]. Non-significant sex differences have been observed in the deciduous dentition [32–34]. However, there has been little research of sexual dimorphism in Carabelli's trait using a suitable scoring method for the deciduous dentition. In addition, Carabelli's trait is present at high frequencies in European derived populations [32] and is therefore likely to be present in this studies group.

1.4. Molar cusp number

Research into sexual dimorphism in the number of molar cusps has been limited. Biggerstaff [35] found males displayed greater cusp numbers in the mandibular deciduous molars than females. In comparison, others have found no sex differences in the mandibular molar cusp numbers [36]. Akin to Carabelli's trait there have been so few studies investigating sexual dimorphism in this trait or in an Australian population that it is thought to be a worthwhile avenue for this study.

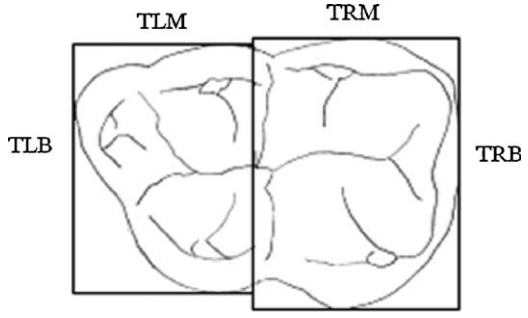

Fig. 1. Diagrammatic representation of the trigonid and talonid size measurements on a second deciduous molar. The trigonid and talonid are divided at the intersection point of the mesial central fossa, buccal groove and protoconid–hypoconoid ridge. Abbreviations of the variables: trigonid mesiodistal (TRM), trigonid buccolingual (TRB), talonid mesiodistal (TLM) and talonid buccolingual (TLB).

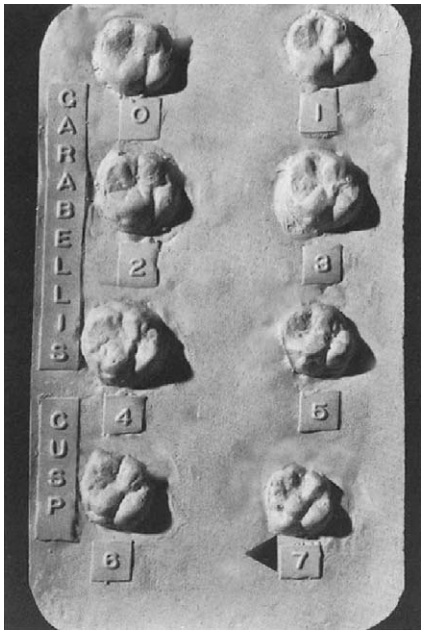

Fig. 2. Dahlberg's scoring system for Carabelli's Trait in upper molars (Arizona State University system plaque 24). Arrow points to Carabelli's trait. Key for scoring Carabelli's trait: 0, smooth lingual side of mesolingual cusp; 1, groove; 2, pit; 3, small Y-shaped depression; 4, larger Y-shaped depression; 5, small cusp which does not extend to the lingual fissure and does not have a free apex of the cusp; 6, medium cusp that has an apex and extends to the lingual fissure; 7, large free cusp.

This study has used a multivariate approach to investigate sexual dimorphism in a number of morphometric crown traits. Two suitable methods are linear functional discriminant analysis (LFDA) and binary logistic regression (BLR) [37–39]. This study tested the following hypotheses on a European derived, Australian sample in the deciduous canine and molars:

1. That the morphometric crown traits are significantly different between the sexes.
2. That sexual dimorphism in the selected morphometric crown traits are great enough to determine sex with a minimum accuracy of 75% as set by the field for the reliable application of a method for sex determination [19].

2. Materials and methods

The sample consisted of 74 females and 77 males, aged between 6 and 13 years of European descent from Sydney, Australia. Skeletons of European descent are the most commonly recovered population in New South Wales, Australia [40]. Written consent was obtained with ethical approval from the University of Sydney (8985).

From each participant, 25 variables (abbreviations are given in Table 1) were recorded from the left arch. There was no significant asymmetry found for crown size ($p = 0.3–1.0$), trigonid size and talonid size ($p = 0.2–0.9$), Carabelli's trait ($p = 0.9$) and cusp number ($p = 0.6–1.0$). Data were collected from OrthoStone dental models made prior to the onset of orthodontic treatment. The models were free of casting errors such as chips or casting material in the grooves. The use of models is common and found to produce more reliable and true measurements than direct intraoral recordings [41]. Metric variables were measured with a Mitutoyo Absolute Digimatic sliding caliper (0.05 mm resolution) with tooled tips for insertion between the teeth. Crown size was measured from the mesiodistal and buccolingual diameter on the canine and, first and second molars. The trigonid size and talonid size were measured from the mesiodistal and buccolingual diameter on the mandibular first and second molars [30]. Carabelli's trait was scored on the maxillary second molar using Dahlberg's [42] classification from zero to seven. The number of molar cusps was counted for all molars.