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Variability in permanent tooth size of three ancient populations in Xi'an, northern China

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ABSTRACT

Objectives: This paper compares permanent dental dimensions between three ancient populations that belonged to the same biological population throughout a temporal range of 2000 years to detect temporal trends and metric variation in dentition.

Materials and methods: The samples analysed were dental remains of 4502 permanent teeth from 321 individuals, which were excavated from three archaeological sites: Chang'an (1000–1300 years BP), Shanren (2200 years BP) and Shaolingyuan (3000 years BP) in the Xi'an region (northern China). For each tooth three standard measurements were taken: Mesio-distal (MD) diameter of crown, labiolingual or buccolingual (BL) diameter of crown and length of root (LR).

Results: Three ancient population samples generally displayed the same dental dimensions ($p > 0.05$), whereas some tooth types varied. The Shaolingyuan had larger canine and the smallest maxillary second molars and the Chang'an had the largest mandibular first molars in the MD dimension. The Shanren had the smallest maxillary third molars and mandibular central incisors, and the Chang'an had the smallest maxillary lateral incisors in the BL dimension. In the LR measures, statistically significant differences of five tooth types showed that the Chang'an were smaller than the Shaolingyuan and the Shanren. Comparisons of coefficients of variation for teeth showed that the length of root and third molar usually displayed greater variation.

Conclusions: Decreasing or increasing trend for crown size does not occur between the ancient populations, while changes in crown size of a few tooth types fluctuate. The root size is more variable than the crown size and is likely to reflect a degenerated trend in a few tooth types.

1. Introduction

Changes in the technology of food preparation over the last few thousand years (especially cooking, softening, and grinding) have led to decreased masticatory system growth in human populations, because of less growth in response to strains generated by chewing softer, more processed food.[1–5] As the masticatory system degenerating, especially in the muscles and the alveolar crests, which creates a tooth-size arch-size discrepancy (excess tooth size compared with the size of the supporting bone), and the secular increases in malocclusion frequency have accelerated in modern industrialized societies during the last hundreds years.[6–9]

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Abbreviations: MD, mesiodistal; BL, buccolingual; LR, length of root; I1, central incisor; I2, lateral incisor; C, canine; P1, first premolar; P2, second premolar; M1, first molar; M2, second molar; M3, third molar.

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The increasingly common problem of malocclusions has led many researchers and clinicians to investigate whether there have been secular trends in diminishing arch sizes or increasing tooth sizes.[10–13]

Although the causes of dental malocclusion are obscure, a contributing factor might be tooth size.[14] The shape and size of tooth are subject to strong genetic control in individual development and the social-environmental factors can affect them in secular evolution.[15–19] Previous studies have shown that the development of food processing techniques led to the reduction of both male and female dental dimensions over early human evolution periods.[20–22] Starting with the onset of the last glaciation approximately 100,000 years ago and continuing to the present, human tooth size reduced at a rate of 1–2% every 2000 years, and the overall rate of dental reduction increased as human evolving.[21] The study conducted by Frayer also had shown that decrease in tooth size occurred within the Upper Palaeolithic samples.[22] Whereas, other data have suggested that tooth sizes had increased over recent generations because of improved nutrition and diminished morbidity.[23–25]

However, the previous studies of dental morphology were usually made by gathering fossil specimens which coming from different sites and spanning a large geographic and chronologic range. It is rare to have available a large hominid fossil samples coming from a single site and spanning a chronologic range. How had the variability and patterning in tooth size of human ethnic groups shown over the last few millennias, associated with cultural changes in food preparation practices following the adoption of agriculture? Comparative analysis of the metric variation in dentition of historic populations coming from a same geographic region should help to clarify the temporal trends.

In this study, we focused on the ancient populations that had lived in the historical period of 3000–1000 years BP in northern China. Since 2002–2005, skeletal remains of adult individuals had been excavated respectively at three archaeological sites of Chang'an, Shanren and Shaolingyuan in the Xi'an region, Shaanxi province, northern China (Figs. 1 and 2). Among the archaeological sites, the Chang'an site was a comparatively integrated communal village sites characterized by a typical feudal social community at its heyday in Tang

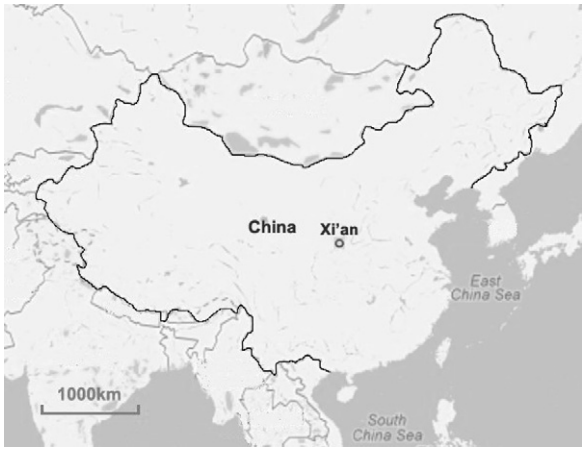

Fig. 1 – Map China indicating location of Xi'an.

Fig. 2 – Map Xi'an indicating locations of three archaeological sites.

dynasty (1100–1300 years BP). Tang dynasty marked a golden era in China. Overseas Chinese today still regard themselves as the ''descendants of the Tang'' and the place where they live as the ''street of the Tang'' (Chinatown). Over the time period of Tang dynasty, intensification of agriculture and improvement of food processing method had made people led a relatively plentiful and stable life. The Shanren site is near to the Qin Shihuang Mausoleum Precinct. In December 2002, an archaeological excavation was conducted at the Shanren kiln site before the construction of the front square of the Qin Shihuang Terracotta Warrior Museum. Two kilns of the Qin Dynasty (about 2200 years BP) together with 121 human skeletons were unearthed. The deceased might have been forced labours for the construction of the mausoleum that had died in a short period and been buried here. The Shaolingyuan site is located in Duqu town, about 5 km in the southeast of Chang'an district in Xi'an. Archaeological excavation was conducted from November 2004 to October 2005. It is assessed to be a family graveyard about 3000 years ago in the Western Zhou Dynasty. The deceased might have been civilians and inferior aristocrats in that culture. The skeletal remains of three ancient populations that lived in the temporal range of 2000 years make it possible for us to clarify the temporal trends of tooth size.

Our study concentrated extensively on the dental morphology of the three ancient populations, and aimed to compare the metric features of tooth in order to determine: whether there are any overall differences in morphology parameters of permanent tooth between the groups, and whether there have been secular trends in diminishing or increasing tooth size.

2. Materials and methods

2.1. *Samples*

Through several excavations and specimen collections in the past years, a large sample of human skulls had been found respectively in three archaeological sites: Chang'an, Shanren and Shaolingyuan in the Xi'an region (northern China). The