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Dental occlusion analysis in the Mesolithic–Neolithic Age, Bronze Age, and Roman to Medieval times in Serbia: Tooth size comparison in skeletal samples

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ABSTRACT

Objective: Anthropological studies have reported that tooth size decreases in the context of diet changes. Some investigations have found a reverse trend in tooth size from the prehistoric to the modern times. The aims of this study were to analyze tooth size in skeletal samples from Mesolithic–Neolithic Age, Bronze Age, and Roman to Medieval times to determine sex differences and establish a temporal trend in tooth size in the aforementioned periods.

Design: Well-preserved permanent teeth were included in the investigation. The mesiodistal (MD) diameter of all teeth and buccolingual (BL) diameter of the molars were measured. Effects of sex and site were tested by one-way ANOVA, and the combined effect of these factors was analyzed by UNIANOVA.

Results: Sexual dimorphism was present in the BL diameters of all molars and MD diameters of the upper first and the lower third molar. The lower canine was the most dimorphic tooth in the anterior region. The MD diameter of most teeth showed no significant difference between the groups, (sample from: Mesolithic–Neolithic Age-group 1; Bronze Age-group 2; Roman times-group 3; Medieval times-group 4), whereas the BL diameters of the upper second and the lower first molar were the largest in the first group. Multiple comparisons revealed a decrease in the BL diameter of the upper second and the lower first molar from the first to the later groups. Lower canine MD diameter exhibited an increase in the fourth group compared to the second group.

Conclusion: On the basis of the MD diameter, a temporal trend could not be observed for most of the teeth. The lower canine exhibited an increase in the MD diameter from the prehistoric to the Medieval times. Changes of BL diameter were more homogeneous, suggesting that the temporal trend of molar size decreased from the Mesolithic–Neolithic to Medieval times in Serbia.

1. Introduction

Human dental occlusion has specific features involving the number of teeth and the size and shape of the teeth and jaw. Changes in one or more of these features will lead to malocclusion. Nowadays, evidence of these orthodontic problems is found in all races and ethnic groups, and these are considered a global problem among contemporary populations (Proffit, Fields, & Sarver, 2007, Chap. 1). Corruccini (1984) suggested that high prevalence of malocclusion is characteristic of western societies and countries undergoing urbanization, implying that "epidemiological transition accompanies the process of modernization/industrialization." From the aspect of the human evolution, changes in dental occlusion are interpreted as a consequence of decrease in jaw and tooth size, with expected further jaw size reduction. Both tooth and jaw sizes are under genetic control (Mossey, 1999). Many studies have reported different degrees of heritability of skeletal and dental structures. Harris and Johnson (1991) found that craniofacial morphology has higher heritability that increases with age, whereas dental characteristics have lower heritability and are more under environmental control.

From the distant past, environmental factors affecting food preparation techniques have changed dramatically (Lucas, 2006; Richards, 2002). Researchers have analyzed how these processes such as the use of the stone tools and cooking have affected the dental morphology. In numerous investigations, tooth size reduction has been observed and described in the societies all over the world in the past 40 000 years (Armelagos, Van Gerven, Goodman, & Calcagno, 1989; Brown, 1987; Frayer, 1977; LeBanc & Black, 1974; Pinhasi, Eshed, & Shaw, 2008; Sciulli, 1997; Sołtysiak,

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2007). Brace, Rosenberg, and Hunt (1987) went further in the past and found evidence of tooth size reduction that began in the late Pleistocene 100 000 years ago at the rate of 1% per 2000 years and proceeded twice as fast in post-Pleistocene populations from 10 000 years ago until the present. Changes in the climate approximately 10 000 years ago have led to a shift from hunting and gathering to the present agriculture and sedentary lifestyle (Richards, 2002). It is considered that this process of "Neolithic revolution" has played a very important role in the reduction of maxillomandibular complex (Armelagos et al., 1989; Pinhasi et al., 2008; Sardi, Novellino, & Pucciarel, 2006; Stynder, Ackermann, & Sealy, 2007). Dietary changes such as consuming more processed and softer food have reduced heavy chewing and strain on the bones, which resulted in decrease in facial growth and maxillary and mandibular arches (Armelagos et al., 1989; Lieberman et al., 2004). As food has become softer and more processed since the industrial revolution, reduction of masticatory function continued and led to smaller and posteriorly rotated mandibles in the post-medieval society (Rando, Hillson, & Antoine, 2014). Food preparation, with changes in the mechanical properties of the food particles, has contributed to further and even larger tooth size decrease (Brace et al., 1987). Several models have been proposed to explain these phenomena (Armelagos et al., 1989; Calcagno & Gibson, 1988; Sołtysiak, 2007). One of the hypotheses suggests that there is a selective tendency toward smaller and simpler teeth resistant to caries due to softer and carbohydrate-rich food (Armelagos et al., 1989).

Despite evidence of tooth size reduction, some investigators have reported that tooth size increased from the prehistoric to the Medieval times. This reverse trend in tooth size during several thousands of years in the prehistory and between the prehistoric and the modern times is considered to be genetic in origin. Jacobs (1994) discovered an increase in tooth size between Mesolithic and Neolithic samples in the Dnieper Rapids region. Mockers, Aubry, and Mafart (2004) have found a larger tooth size in the modern population than in the Copper Age sample in France. Contrary to this, tooth size differences observed in the last centuries may be environmentally influenced. Increase in tooth size from medieval to modern populations is interpreted as a consequence of reduced interproximal wear (Harper, 1994), better nutrition and health care, and reduced morbidity (Lindsten, Ögaard, & Larsson, 2002).

Different trends in tooth size changes in various regions throughout human history impose the need for further research. This implies that tooth size changes should not be generalized for different populations. Considering the lifestyle changes, food preparation technique, and food consistency, it is very important to discover whether and, if so, how they affect tooth size and consequently malocclusions in one region over a long period, from prehistory to the present. In addition, it is important to test the effects of those changes on male and female dentitions. This knowledge would contribute to the better understanding of dental morphology changes and help in foreseeing possible trends in the future. Some studies have investigated tooth size variations in one region during several thousands of years (Armelagos et al., 1989; Brace, 1976; Huang, Kang, Liu, Duan, Shao, 2012; Pinhasi et al., 2008; Sołtysiak, 2007). Most of these studies were conducted on samples of the prehistoric populations, including several thousands of years before and after the Neolithic revolution (Pinhasi et al., 2008; Sołtysiak, 2007). However, there was not much evidence of a temporal trend in the later periods (Armelagos et al., 1989; Brace, 1976). In Serbia, there is evidence of tooth size changes in skeletal samples from the period between Mesolithic and Early Bronze Age (Pajević, Sessa, Juloski, & Glišić, 2012). However, there are no records of tooth size variations with respect to sex and time in the later stages of history, or, if they were present, what their direction was. On that premise, the aims of this study were to (a) analyze tooth size in skeletal samples from Mesolithic–Neolithic through Bronze Age and Roman and Medieval times; (b) determine sex differences; and (c) establish possible temporal trend in tooth size spanning from Mesolithic to Medieval Serbia and determine possible sex differences in this trend.

2. Materials and methods

The skulls used in this study are a part of the large paleoanthropological collection of the Department of Archaeology, Faculty of Philosophy, University of Belgrade, and collection of the National Museum of Kikinda, Serbia. Permission for the investigation was obtained from the relevant institutions.

The skeletal samples were divided into four groups according to the chronology and site. The first group included two Mesolithic–Neolithic sites belonging to the same culture of Lepenski Vir, i.e., Lepenski Vir and Vlasac. These sites are located in the Iron Gate region called Upper Gorge. The second group comprised teeth from the Early Bronze-Age necropolis Mokrin. The third group included teeth from the Roman city of Viminacium and the fourth group comprised teeth from the medieval archeological site of Vinča (Table 1 and Fig. 1).

Data on the sex and age of the osteological material were obtained from previous studies (Girić, 1971; Mikić, 1993, 2009; Nemeskéri & Szathmáry, 1978). For the investigations, only jaws with permanent dentition were used. The inclusion criteria for the teeth were as follows: (1) presence of well-preserved anterior and posterior teeth with wear in enamel or dentin, without advanced wear near the pulp and beyond; tooth wear was evaluated using the Smith and Knight tooth wear index (Smith & Knight, 1984; Bradsley, 2008); (2) absence of interproximal surface damages such as caries, chips, and grooves; and (3) absence of postmortem damages. The teeth from the right quadrants of both the upper and the lower dental arches were chosen for the analysis. If one of the teeth was missing, a tooth from the opposite side of the jaw was used if present.

The mesiodistal (MD) diameters of all teeth and the buccolingual (BL) diameters of molars were measured using a digital caliper (Dentaurum, Germany) with an accuracy of 0.1 mm. Tooth measurements were performed according to the method described

Table 1
Four investigated groups of teeth according to the archeological site.

Archeological site	Age, Chronological period	Number of investigated teeth
Lepenski Vir and Vlasac[a]	From Early Mesolithic (ca.8500–7500 B.C.) to Middle Neolithic (ca.5900–5500 B.C.)	134
Mokrin[b]	Early Bronze Age (ca.2100–1800 B.C.)	159
Viminacium[c]	First to fourth century	219
Vinča[d]	Middle Ages (8th to 17th century)	154

[a] Borić (2008).
[b] Porčić and Stefanović (2009).
[c] Mikić (1993).
[d] Mikić (2009).