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Radiomorphometric indices of mandibular bones in an 18th century population

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ABSTRACT

Objective: To estimate four radiomorphometric indices of mandibular bones in an 18th century population sample, and possibly associate the findings with bone mass loss related to sex, age, nutritional habits and pathologies reflecting on the bone.
Design: Thirty-six sculls (31 males, 5 females), recovered from the crypt of Požega Cathedral in Croatia were analyzed. Age estimation was based on tooth wear, and Eichner class was determined according to the number of occlusal supporting zones. The parameters in recording analogue orthopantomographs were set to constant current of 16 mA, exposure time of 14.1 s, and voltage between 62–78 kV. Films were processed in an automatic dark chamber processor for 12 min, and digitized at 8-bit, 300 dpi. The thickness of the mandibular cortex was assessed below the mental foramen (MI), at antegonion (AI), at gonion (GI). Qualitative mandibular cortical index (MCI) was assessed.
Results: Average values of MI, AI and GI were 3.97 ± 0.94 mm, 2.98 ± 0.56 mm, and 1.99 ± 0.55 mm, respectively. Statistically significant differences between males and females were found for AI right ($p = 0.014$), GI left ($p = 0.010$) and GI average ($p = 0.006$), and were in all cases higher in males. There were no statistically significant differences between age groups for either index ($p > 0.05$). Considering Eichner classification the differences were not significant for MI ($p = 0.422$), AI ($p = 0.516$), and GI ($p = 0.443$), but in Eichner classes II, MCI was significantly higher ($p = 0.02$).
Conclusion: The obtained data does not suggest generalized malnutrition or calcium, phosphorus and vitamin D deprivation in the historic population studied.

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1. Introduction

The assessment of bone density in ancient skeletal remains is a very valuable method since it may indicate nutritional habits, vitamin deprivation and the presence of various pathologies reflecting on the bone pattern. According to the available literature densitometric studies on skeletal remains of various historic populations have been done, but not on jaws.[1–3] During the first three decades of life bone synthesis predominates, so bone mass is at its highest point in the second half of the third decade, and then bone mass decreases at a rate of less than 1%/year, except in women during menopause when it decreases at a higher rate.[4] On the individual level, the factors influencing bone mass include genetics, delayed menarche and hormonal imbalances (for example diabetes mellitus, hyperthyroidism, hypogonadism, hyperparathyroidism, Cushing syndrome can all lead to reduced bone mass), and physical activity.[5,6] The activity of muscles attaching to bones affects bone density. The greater the contractile capacity of a muscle and the greater the force it liberates on contraction leads to higher bone mass at sites of muscle attachment to the bone.[6] At the level of a whole population, either protein or protein-calorie malnutrition could be the underlying causes of decreased bone mass i.e. osteopenia.[1,2] Besides caloric intake, several vitamins A, D, C, and K, and micronutrients like calcium, magnesium, and zinc may affect bone formation.[7]

Radiographic assessment of jaw bones is of great value in estimating quality and quantity of other bones in the body, and based on particular radiographic finding, some systemic or local conditions could be presumed, such as resorption or osteoporosis. A number of quantitative and qualitative radiographic assessments of mandibular bones were introduced and used for this purpose, including densitometric and morphometric ones.[8–10] Widely used qualitative index of mandibular bone assessment is mandibular cortical index (MCI).[11] Mandibular cortical thickness measured at different points of the lower mandibular border represent quantitative indices.[10,12–14] Although using radiomorphometric indices in diagnosing low bone mass density (BMD) at the axial skeleton has been questioned, it is generally accepted as auxiliary method in identifying bone mass loss,[15,16] and in a number of studies orthopantomographs were used in recognizing patients with lower BMD as well.[11,17,18] Good correlation between mandibular and skeletal BMD has been reported: BMD measured by dual-energy X-ray absorptiometry (DXA) in the mandible was shown to be positively correlated with BMD in lumbar spine, femoral neck and forearm.[19–22] Also, it was reported that panoramic radiomorphometric indices are significantly correlated with mandibular BMD.[19,20,23]

The aim of this study was to assess mandibular cortical index (MCI), and perform the measurements of radiomorphometric indices (mental (MI), gonial (GI) and antegonial index (AI)) on a historic sample from the 18th century. Furthermore the aim was to compare the recordings according to sex, age, and the number of occlusal supporting zones.

2. Materials and methods

2.1. *Sample selection*

Osseal remains included 175 sculls. They were recovered in 2005 from the crypt of Požega Cathedral (Croatia) after the floor deteriorated. In the part of the crypt under the sanctuary priests were buried, and in the rest of the crypt members of respectable families and professions (joudge, senator, physician, notary, organ player, craftsman, miller). In 1769 burial fee was 16 forints. It is interesting that the crypt was used as burial site long after the decree of Joseph II from 1784, by which he ordered closing of all the church crypts. In fact, the last burial was in 1867. During the 19th century room for coffins was made by removing the remains of old coffins and placing the human remains in three biers. When the crypt was entered in 2004–2005, we recovered the osseal remains belonging to the 18th century population from the biers.

The material was carefully cleaned and examined at the School of Dental Medicine at Zagreb University, and afterwards returned to the original site. Of the 175 sculls recovered, only 36 were chosen for densitometric analysis. The chosen specimens were older than 15 years i.e. had only permanent dentition, sex and age could be determined and vertical and horizontal dimensions were reproducible.

The age estimation was based on tooth wear analysis.[24] Sex estimation was made from the sculls alone, and was based on the shape of supraorbital ridges, nuchal crests, mastoid processes and muscular ridges. The specimens were further classified according to Eichner- dependent on the number of occlusal supporting zones.[25] Eichner recognizes four occlusal supporting zones: two in molar and two in premolar regions. There must be at least one intermaxillary contact in the zone for it to be counted. In class I (or A) there are contacts in all four supporting zones, in class two (or B) in less than four zones, and in class III (or C) there are no occlusal contacts. Class II is further subdivided into II-1 with three supporting zones, II-2 with two supporting zones, II-3 with one, and II-4 with anterior tooth contact but no supporting zones contact. There are three subclasses in groups I and III depending on the teeth missing.[25] Only Eichner's classes I and II were used in the investigation because horizontal and vertical dimensions could easily be reproduced. This could explain way the oldest group analyzed counted least individuals. Besides, the Lovejoy ageing method of assessing occlusal tooth wear tends to underage the older individuals.[24]

2.2. *Radiographic examination*

Before recording each orthopantomograph, mandible was fixed to the skull with self-adhesive tape. The skull was attached to a wooden stand at a height of 1.5 m, and position was the same for all specimens. The recording parameters were set to constant current of 16 mA and an exposure time of 14.1 s; the kV varied between 62 and 78 kV (Sirona model no. 5968573 D3 200; Siemens, Munich, Germany). Images were recorded using radiographic film (ORTHO CP-G PLUS Agfa; Agfa-Gevaert Group, Mortsel, Belgium). The films were processed in an automatic dark chamber processor (XR 24 Nova; Dürr Dental GmbH u. Co