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DENTAL PATHOLOGIES AND ANOMALIES IN A SAMPLE OF HUMAN SKULLS FROM THE MAUSOLEUM CRYPT OF THE FIRST WORLD WAR HEROES, IN IAŞI (IAŞI COUNTY, ROMANIA)

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The present study describes odontopathies and anomalies identified in a sample of 50 human skulls collected from the Mausoleum Crypt of the World War I Heroes in Iași-*Calea Galata* (Iași County, Romania). The skulls, found during the rehabilitation project of the edifice in 2020-2021, belonged to four adolescents (three males and one female), 25 young adults (22 males and three females), 19 middle adults (males) and two old adults (males). The distribution by sex indicates a high frequency of males (*i.e.*, 46 males and four females: a masculinity index of 8.69). In the analysed sample, the following dental pathologies and anomalies were identified: caries (22%), enamel hypoplasia (18%), supragingival calculus (16%), radicular remains (12%), radicular cyst (4%), edentia (4%), and accessory cusps (2%).

Keywords: odontopathies and anomalies, human teeth, Mausoleum of World War I Heroes, Iași, Romania

INTRODUCTION

The teeth, the hardest and most chemically stable tissues in the body, are often the only part of the body that survives to be recovered from a necropolis, because of its robust structure. The tooth is, therefore, an excellent material for paleoanthropological investigations (*e.g.*, morphometrics, genetics, stable isotopes etc.), providing information on diet, oral hygiene and dentistry, occupation, cultural behaviour, and subsistence economy [5,29,44,47].

Dental paleopathology identifies and interprets diseases and abnormalities of teeth and jaws in past populations. Analysis of dental diseases and anomalies is carried out according to two large research traditions: one focused on the relationship between odontopathies and cultural factors such as diet, nutrition, and subsistence; the other on the dental development abnormalities, that are influenced to a greater extent by genetic factors [34]. Infection is one of the more common dental diseases in archaeological populations (*e.g*. caries), while degenerative disorders include ante-mortem tooth loss following periodontal disease and recession of the jaw bones, usually as the person ages [44]. Developmental problems include enamel hypoplasia and genetic anomalies (*e.g.*, lack of one or more than the expected number of teeth) [44]. Enamel hypoplasia is used as a nonspecific indicator of stress and malnutrition, being considered a valuable source of information for the anthropological research of ancient populations [53,55]. It must be emphasized here that the dental diseases do not develop isolated from one another, a complex relationship existing between them [31].

The present study analyzes the frequency and characteristics of the odontopathies and anomalies identified in a sample of human skulls from the Mausoleum Crypt of World War I Heroes in Iași-*Calea Galata* (Iași County, Romania) (Fig. 1/a, b). The analysed sample was collected during monument rehabilitation performed in 2020-2021, under the coordination of archaeologist PhD Mădălin-Cornel Văleanu.

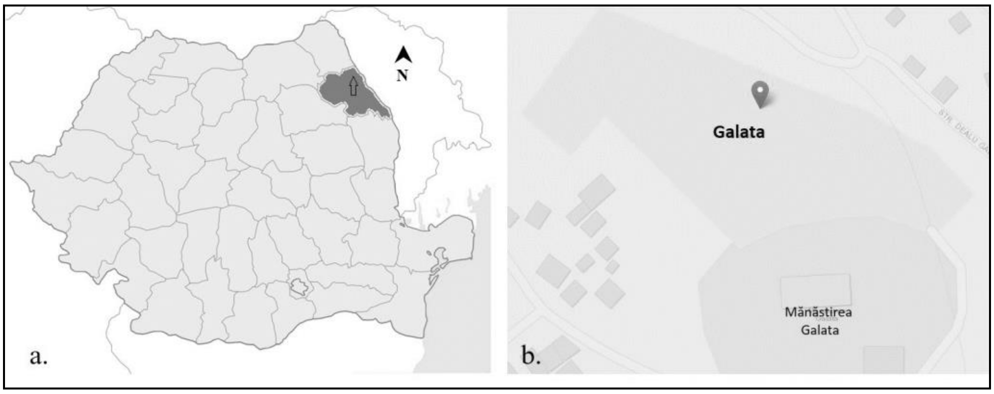

Figure 1. Location of the Mausoleum of World War I Heroes in Iași-*Calea Galata* (Iași County, Romania): general (a); detail (b); (Source: http://ran.cimec.ro/)

MATERIAL AND METHODS

The analysed sample includes 50 skulls randomly collected from the Mausoleum Crypt of World War I Heroes in Iași-*Calea Galata* (Iași County, Romania) during the rehabilitation of this monument, in 2020-2021; the skulls were codified as C1 → C50. We mention that the mandibles are missing in all 50 skulls.

Estimation of age at death, in the case of the individuals that did not reach the age of 20 years, was done according to the methodology recommended by Schaefer *et al*., 2009; Ubelaker, 1979; Ubelaker, 1989 [45,57,58]. In the case of individuals older than 20 years, estimations of age at death and sex used the models, criteria and techniques recommended by Brothwell, 1981; Lovejoy, 1985; Meindl and Lovejoy, 1985; Latham and Finegan, 2010; Ubelaker, 1979 and Walrath *et al*., 2004 [6,30,36,28,57,60].

In our investigation, the odontopathies and anomalies are evaluated by macroscopic observations. To identify dental pathologies and anomalies, the teeth were cleaned with a soft brush to remove particles that would have impeded visual inspection.

Caries, when they affected dentin, were recorded based on their position and gravity [40]. Also observed was the presence of radicular remains and root cysts. The radicular cyst appears as a large cavity in the bone, with regular walls around the dental apex [7].

We identified cases of edentia consisting in the partial absence of teeth in the jaws due to falling after eruption, as caused by several factors [22].

Dental calculus or plaque (grey-white mineralized plaque composed primarily of calcium phosphate) is firmly attached to the dental surface. Depending on the positioning on the tooth crowns or exposed roots, the dental calculus can be supragingival or subgingival [59]. Dental calculus should be reported as "0" (absent), "1" (small amount), "2" (moderate amount), "3" (large amount) [6].

Dental enamel hypoplasia was analysed according to the DDE Index, but other registration methods have been also considered. The severity degree was established according to the method proposed by King, Hillson and Humphrey [26]. In recording the hypoplasia type, four main categories have been considered: pits, horizontal ditches, vertical ditches, and areas wholly devoid of enamel [64]. Enamel hypoplasia was observed on two anatomic dental surfaces: labial and buccal. It was established whether the hypoplasic defect is singular or multiple, well-delimited or diffuse [64]. Also, estimation of the age at which the hypoplasic defect first appeared was based on the method proposed by Goodman, Armelagos and Rose [12].

A tooth anomaly observed in this osteological sample is represented by the accessory cusps – a common variation in tooth morphology [37].

RESULTS AND DISCUSSION

The teeth here analysed belonged to 50 human skeletons – four adolescents (three males and one female), 25 young adults (22 males and three females), 19 middle adults (males), only two belonging to old adult (males).

Analysis of frequency by sex revealed 46 males *vs* four females, with a masculinity index of 8.69. The upper teeth were well preserved. The odontopathies and anomalies found in the analysed sample of skulls are shown in Table 1. The frequency was calculated for the two sexes, as well as for the entire sample. We identified caries (22.00%), enamel hypoplasia (18.00%), supragingival calculus (16%), radicular remains (12%), radicular cyst (4.00%), edentia (4.00%) and accessory cusps at one molar (2.00%) (Table 1).

Table 1

Frequency of odontopathies identified in the sample

Odontopathies	**Male (14-x years)**		**Female (14-x years)**		**Total**	
	N	(%)	N	(%)	N	(%)
Caries	10/46	21.73	1/4	25.00	11/50	22.00
Radicular remains	5/46	10.86	1/4	25.00	6/50	12.00
Radicular cyst	2/46	4.34	–	–	2/50	4.00
Edentia	2/46	4.34	–	–	2/50	4.00
Supragingival calculus	7/46	15.21	1/4	25.00	8/50	16.00
Enamel hypoplasia	9/46	19.56	–	–	9/50	18.00
Accessory cusps	1/46	2.17	–	–	1/50	2.00

DENTAL CARIES

Dental caries result from demineralization or decay of the crown and root of a tooth. Caries form when bacteria create organic acids which are destructive to enamel, dentin, and cementum; they often initiate as pits and small fissures of teeth, rendering molars most susceptible to caries development, followed by premolars, and lastly by the anterior teeth [16]. Caries frequency between human populations is an indicator of varying food resources, evidencing the nutritional distinction between hunter-gatherers and agriculturalists [2,56,33,48]. Caries are closely related to diet, because caries-causing bacteria use food particles in the mouth to produce harmful acids [3]. The most common and well-studied bacterium that causes caries is *Streptococcus mutans* [18]. Sugars, specifically sucrose, are strongly related to caries development, because their small size enables them to readily enter and adhere within the bacterial matrix for fermentation; other food molecules like proteins, fats, and complex carbohydrates are often too large for attachment [18].

Caries have a multifactor etiology, presenting various degrees, from opaque stains to large cavities affecting the teeth [43]. Due to their close association with diet and its abundance within many populations, caries frequency is one of the most important observations for bioarchaeologists, because they learn about a population's culture by studying dentition [27]. The main factors influencing dental caries are: environmental factors (oligoelements present in food and water), pathogenic agents (bacteria causing the disease), other exogenous factors (diet, oral hygiene) and endogenous factors (teeth shape and structure) [41].

In this study, dental caries was observed in 11 subjects, more accurately: 10 males aged between 20 and 50 years (Figs. 2-4; Fig. 5/a, b; Figs. 6-11) and one female aged 25-30 years (Fig. 12). The teeth affected by caries are the upper premolars and molars. Different types of caries have been identified: interproximal, cervical, occlusal and root caries.

RADICULAR REMAINS

The term tooth wear denotes the gradual loss of dental hard tissues and involves various processes: attrition, erosion, and abrasion. Dental attrition is a physiological wearing of teeth resulting from tooth-to-tooth contact without the presence of foreign substances [23]. Tooth abrasion occurs by the friction of exogenous materials forced over tooth surfaces, especially food and acidic substances. Erosion is defined as the progressive, chemical dissolution of tooth surface without the presence of bacteria and plaque [23]. When looking at teeth from all periods of human history, from Prehistory to the Middle Ages, we can note that dental wear is a common occurrence [11,17]. Dental attrition includes two forms: occlusal attrition resulting from the contact between the biting surfaces of upper and lower teeth, and interproximal attrition, a consequence of a slight movement between adjacent teeth in the same jaw [20,63]. Variations in the consistency of food, food preparation methods, and grit contained in food produce dental abrasion patterns consistent with the well-documented patterns of attrition that reflect the biomechanics of mastication. Five degrees of dental abrasion established by Périer are used to highlight the disappearance of enamel and dentin [9]. The fifth degree is represented by pronounced abrasion, leading to the disappearance of the crown, which makes visible the pulp chamber. This is how radicular remains result.

Radicular remains were identified in six male subjects, aged between 20 and 55 years (Figs. 13-15), affecting the upper premolars (P^1, P^2) and molars (M^1, M^2).

RADICULAR CYSTS

Radicular cysts are odontogenic in nature and relatively uncommon in primary dentition, accounting for just 0.5 to 3.3% of all radicular cysts in both primary and permanent dentition [54]. They are not the result of maldevelopment but of infection of pulp cavity and root canal of an erupted tooth. A cyst starts as an apical abscess or granuloma and secondarily acquires an epithelial lining from remnants of the epithelial sheath of the dental root [40]. It may be located on any erupted tooth of the mandible or maxilla, and it is always intimately associated with the root. This tooth may have fallen out, but its alveolus was still connected with the cyst cavity. In contrast to the dentigerous cyst, where the tooth is below the cyst, in the radicular cyst the tooth is placed above [40].

The radicular cyst was reported in two male subjects, aged between 30 and 50 years, affecting the upper right first incisor – I^1 (Fig. 19), and the upper right first premolar – P^1 (Fig. 20).

Edentia consists of the partial or total absence of teeth in the oral cavity, caused by their falling after eruption due to several factors. The main cause for edentia is represented by the dental caries and its complications. There are also other disorders, such as infections of the soft tissues or bone tissues (osteomyelitis), tumours or facial traumas which can cause edentia [22]. Edentia can be frontal (missing incisors and canines, with interlaced spaces), lateral (missing premolars and molars, where the spaces can be unilateral or bilateral), terminal (uniterminal or biterminal), mixed (interlaced and terminal spaces), subtotal (with 1–2 remaining teeth), or complete – including both the upper and the lower jaws [52].

Lateral edentia was identified in two male subjects, aged between 40–50 years (Figs. 21, 22), the buccal teeth being also affected.

DENTAL CALCULUS

Dental calculus is calcified dental plaque that includes microbial, and dietary DNA and proteins, dietary fibres, airborne and waterborne pollutants, gingival crevicular fluid, and calcium phosphate minerals [50,61]. Many factors can impact its bacterial composition, including personal hygiene, host genetics, diet, and environmental factors [1,61]. Archaeological and epidemiological evidence showed that human populations worldwide develop dental calculus; its incidence increased with the advent of agriculture [4], but it decreased as a result of modern oral hygiene habits (*e.g.* daily tooth brushing and annual teeth cleanings by a dental hygienist) [50,62]. In archaeology, the study of dental calculus has been approached macroscopically (quantity and location of calculus deposits on teeth), microscopically (debris entrapped in it), and more recently, biomolecularly [42]. Early works on dental calculus focused on macroscopic quantification and location of calculus found [10], an approach still used [21,25,42].

There are two forms of calculus, depending on its localization, either on the tooth crown or the exposed roots: supragingivally and subgingivally, respectively [59]. There is an inverse relationship between calculus and caries, since the first needs an alkaline environment to develop, whereas caries develops in an acidic environment, which leads to the logical conclusion that the two processes are incompatible [59]. This calcified plaque appears most frequently on the teeth located closest to the salivary glands (especially on mandibular incisors and maxillary molars) [44].

Supragingival dental calculus was identified in eight subjects: seven males aged between 18 and 35 years (Fig. 23/a, b; Fig. 24; Fig. 25/a, b; Fig. 26–29) and one 20–25 year-old female (Fig. 30), in the upper molars and premolars, mainly on the buccal surface.

DENTAL ENAMEL HYPOPLASIA

Teeth can also indicate other events in a person’s life, particularly during the growing years, when the body is developing [44]. In biological anthropology, dental enamel defects (the most common being enamel hypoplasia) have attracted the attention of many researchers, in their studies performed on both old and modern populations [44]. These odontopathies are often considered as a non-specific indicator of stress, being defined as deficiencies in enamel matrix composition [15]. Three types of enamel hypoplastic defects can be found – linear, pit and planar, which are believed to be formed by different mechanisms [16]. These defects can occur only while the teeth are developing, remaining as a permanent record in adulthood. Many factors are relevant for enamel defect aetiology [44], broadly categorized into hereditary anomalies, localized trauma, and systemic metabolic stress (*e.g.*, a nutritional deficiency or a childhood illness – such as measles) [14]. One or several hypoplasic signs may occur on the same tooth, their severity ranging from microdefects, visibile only microscopally, up to macroscopically perfectly visible defects [51]. Frequently, the hypoplasic defects appear bilaterally (left and right), both on the lingual and labial/ facial surfaces of the crown, preponderantly on the last one [19]. Their localization is more frequent in the median third of the crown, followed by the cervical and incisal/ occlusal thirds [13].

In the series under analysis, linear enamel hypoplasia (LEH) was identified in nine males aged between 20 and 45 years (Figs. 31, 32/a, b; Figs. 33–39). Enamel hypoplasia affected one or only a few teeth (acquired dental dysplasia). Hypoplasic defects are of horizontal linear type, being usually localized on the facial and buccal surfaces, in the median third of the crown. In the majority of dental crowns affected with hypoplasia, at least well-delimited defects and several diffuse lines can be observed, which suggests that, at young ages, the analyzed subjects have suffered some physiological disorders. The extent of hypoplasia severity is a moderate one. The age interval at which an acute physiological stress was manifested ranges, generally, between 1.5 and 4 years.

ACCESSORY CUSPS

Accessory cusps are relatively rare anomalies, as variations of tooth morphology, occasionally observed clinically [37]. However, their incidence differs, depending on the type and tooth affected. Three of the most reported variations of accessory cusps are: Carabelli cusps of the molars, Talon cusps of the incisors and Leong's tubercle of the premolar. These variations can be seen in both primary and permanent dentitions [37–39], with different frequencies, depending on the type: between 1% and 7.7% for Talon cusp [8,49], 52% and 68% for Carabelli cusp [24,35] and 8% for Leong's tubercle [46], respectively. Although these additional cusps are rare, their presence may complicate the daily routine of oral care. Pits and grooves surrounding the cusps are highly susceptible to caries [37].

Three accessory cusps were identified in a male of about 35 years, at the level of the right upper third molar (M^3) on the occlusal surface (Fig. 40).

CONCLUSIONS

The human skulls analyzed in this study were randomly sampled from the Mausoleum Crypt of the World War I Heroes of Iași-*Calea Galata* (Iași County, Romania), during its rehabilitation between 2020 and 2021. The sample consists of 50 skulls belonging to four adolescents (three ♂ and one ♀: 8.00%), 25 young adults (22 ♂ and three ♀: 50.00%), 19 middle adults (19 ♂: 38%) and only two old adults (one ♂: 4.00%).

Dentition can provide a unique insight about those who lived in the past, concerning their diet and cultural practices. In this sample, dental caries (22.00%), dental enamel hypoplasia (18.00%), supragingival dental calculus (16.00%), radicular remains (12%), radicular cyst (4.00%), edentia (4.00%) and additional cusps (2.00%) were evidenced.

Dental caries is one of the most prevalent chronic diseases affecting the human body. In the contemporary society, it encompasses all population groups from all geographic areas of the world. It affects both sexes, every age group, and all socio-economic strata [4]. The literature mentions that females have higher rates of caries than males, because of cultural practices and natural physiological differences, which are thought to put females at increased risk [32].

In enamel hypoplasia, the teeth record evidence of stressful events, such as malnutrition and childhood disease [4]. Dental enamel hypoplasia is a nonspecific indicator of health or/and nutritional status in human populations, suggesting biological fragility during their attempt of adapting thelselves to environmental changes.

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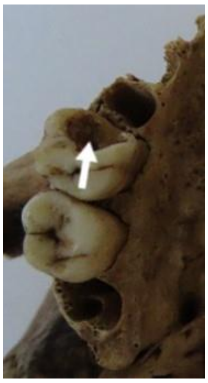

Figure 2. Subject C1, ♂, 30–35 year-old: occlusal surface caries (gr. II) on the upper right first molar (M^1)

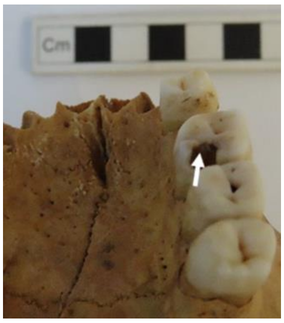

Figure 3. Subject C4, ♂, 40 year-old: occlusal surface caries (gr. I→II) on the upper left first molar (M^1)

Figure 4. Subject C11, ♂, 20–25 year-old: interproximal caries (gr. I→II) on the upper right first and second premolars and first molar (P^1, P^2, M^1); interproximal caries (gr. I→II) on the upper left second premolar (P^2)

Figure 5. Subject C15, ♂, 40–45 year-old: a. occlusal surface caries (gr. I) on the upper right first and third molars (M^1, M^3); b. interproximal caries (gr. I) on the upper right second premolar (P^2)

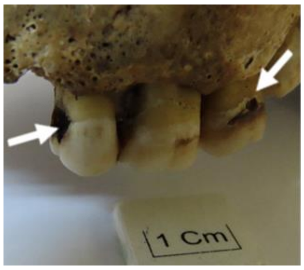

Figure 6. Subject C21, ♂, 40–45 year-old: cervical caries (gr. I→II) on the upper left second premolar and molar (P^2, M^2)

Figure 7. Subject C25, ♂, 20–25 year-old: interproximal caries (gr. I) on the upper right first premolar (P^1); root caries (gr. I) on the upper right third molar (M^3)

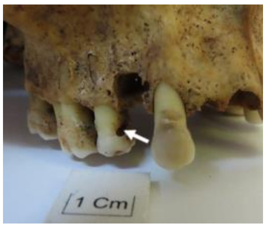

Figure 8. Subject C29, ♂, 50–55 year-old: root caries (gr. I) on the upper right second premolar (P^2)

Figure 9. Subject C31, ♂, 40–45 year-old: cervical caries (gr. I) on the upper left second molar (M^2)

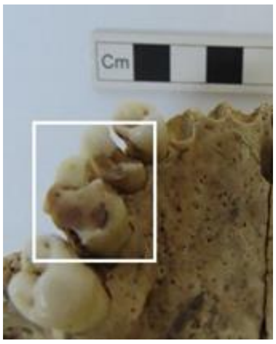

Figure 10. Subject C37, ♂, 25–30 year-old: interproximal caries (gr. II) on the upper right second premolar and first molar (P^2, M^1)

Figure 11. Subject C39, ♂, 35–40 year-old: occlusal surface caries (gr. IV) on the upper right first molar (M^1)

Figure 12. Subject C34, ♀, 25–30 year-old: cervical caries (gr. I) on the upper left first and second molars (M^1, M^2)

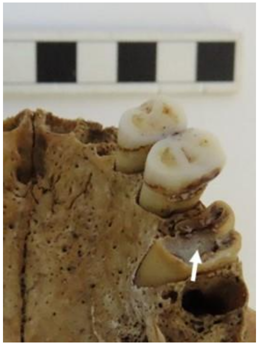

Figure 13. Subject C6, ♂, 45–50 year-old: radicular remain of the upper left first molar (M^1)

Figure 14. Subject C10, ♂, 30–35 year-old: radicular remain of the upper right second premolar (P^2)

Figure 15. Subject C31, ♂, 40–45 year-old: radicular remain of the upper left first premolar (P^1)

Figure 16. Subject C33, ♀, 20–25 year-old: radicular remain of the upper right first premolar (P^1)

Figure 17. Subject C45, ♂, 50–55 year-old: radicular remain of the upper right first molar (M^1)

Figure 18. Subject C48, ♂, 30–35 year-old: radicular remain of the upper right and left first molar (M^1)

Figure 19. Subject C28, ♂, 30–35 year-old: root cyst of the upper right first incisor (I^1)

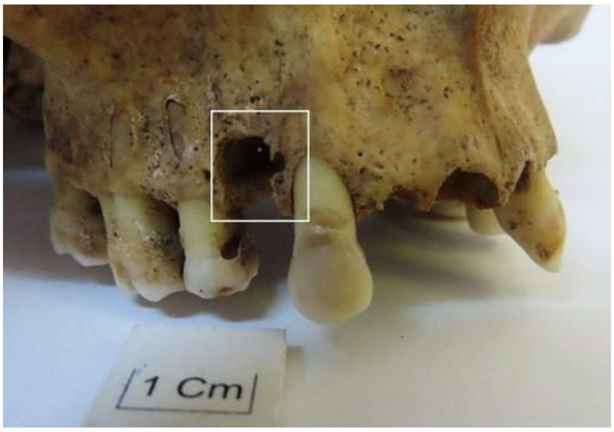

Figure 20. Subject C29, ♂, 50–55 year-old: root cyst of the upper right first premolar (P^1)

Figure 21. Subject C44, ♂, 40–45 year-old: upper jaw with lateral edentia

Figure 22. Subject C46, ♂, 50 year-old: upper jaw with lateral edentia

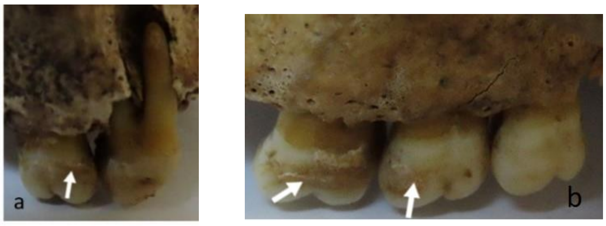

Figure 23. Subject C1, ♂, 30–35 year-old: a. supragingival dental calculus, moderate amount (2), on the upper right second molar (M^2); b. supragingival dental calculus, moderate amount (2), on the upper left first and second molars (M^1, M^2)

Figure 24. Subject C10, ♂, 30–35 year-old: supragingival dental calculus, moderate amount (2), on the upper right first premolar (P^1) molar (M^1)

Figure 25. Subject C13, ♂, 18–20 year-old: supragingival dental calculus, moderate amount (2), a. upper right first molar (M^1) (buccal surface); b. upper left first and second molars (M^1, M^2) (buccal and lingual surface)

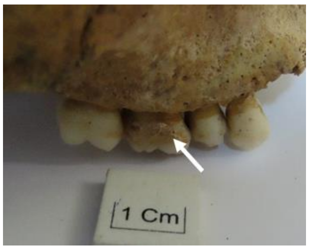

Figure 26. Subject C19, ♂, 20–22 year-old: supragingival dental calculus, moderate amount (2), on the upper right first molar (M1)

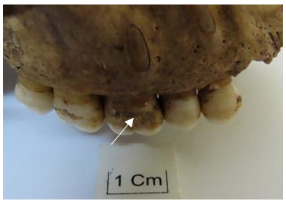

Figure 27. Subject C22, ♂, 30–35 year-old: supragingival dental calculus, moderate amount (2), on the upper right first molar (M1)

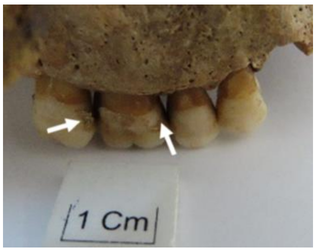

Figure 28. Subject C27, ♂, 20–25 year-old: supragingival dental calculus, moderate amount (2), on the upper right first and second molars (M^1, M^2)

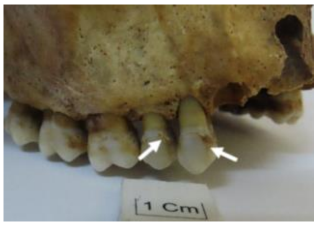

Figure 29. Subject C28, ♂, 30–35 year-old: supragingival dental calculus, small amount (1), on the upper right first and second premolars (P^1, P^2)

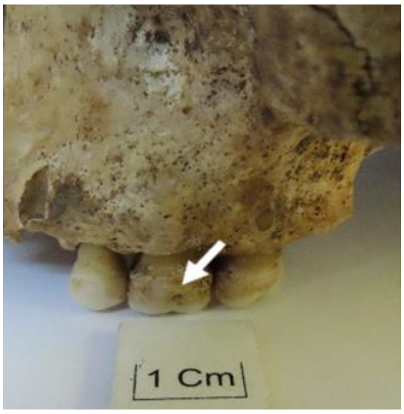

Figure 30. Subject C33, ♀, 20–25 year-old: supragingival dental calculus, small amount (1), on the upper left first molar (M^1)

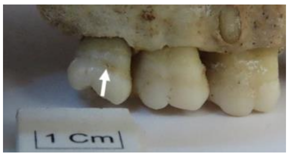

Figure 31. Subject C3, ♂, 35–40 year-old: linear enamel hypoplasia (LEH) on the upper right third molar (M^3)

Figure 32. Subject C10, ♂, 30–35 year-old: linear enamel hypoplasia (LEH). a. upper right first molar (M^1); b. upper left first premolar (P^1) and second molar (M^2)

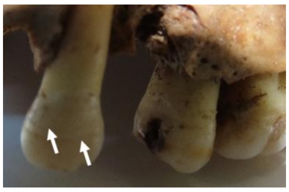

Figure 33. Subject C15, ♂, 40–45 year-old: linear enamel hypoplasia (LEH) on the upper right canine (C)

Figure 34. Subject C20, ♂, 35–40 year-old: linear enamel hypoplasia (LEH) on the upper right canine and second incisor (C, I^2)

Figure 35. Subject C25, ♂, 20–25 year-old: linear enamel hypoplasia (LEH) on the upper left canine (C)

Figure 36. Subject C26, ♂, 30 year-old: linear enamel hypoplasia (LEH) on the upper right canine and first premolar (C, P^1)

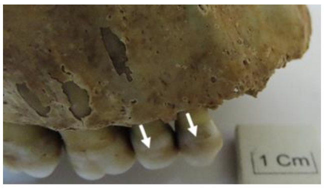

Figure 37. Subject C31, ♂, 40–45 year-old: linear enamel hypoplasia (LEH) on the upper right first and second premolars (P^1, P^2)

Figure 38. Subject C42, ♂, 30–35 year-old: linear enamel hypoplasia (LEH) on the upper right canine (C)

Figure 39. Subject C48, ♂, 30–35 year-old: linear enamel hypoplasia (LEH) on the upper left first molar (M^1)

Figure 40. Subject C50, ♂, 35 year-old: upper jaw – accessory cusps of the upper right third molar (M^3), occlusal surface

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