The analysis of enamel hypoplasia on teeth of a skeletal population from Roman Vinkovci–Cibalae, Croatia

• Peko D*•

Student – School of Dental Medicine, University of Zagreb, Croatia

*Mentor: Marin Vodanović - School of Dental Medicine, University of Zagreb, Croatia

Address for correspondence:
Dunja Peko
School of Dental Medicine, University of Zagreb
Gundulićeva 5,
10000 Zagreb, Croatia
E-mail: dpeko@sfzg.hr

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Abstract

Reconstruction of ancient people's lives can be accomplished by studying their dental remains. They present a valuable source of information about the type of food people ate, illnesses they suffered from and social stratification within a community. Analysed dental remains refer to the antique period, between the 3rd and the 5th century. Romans lived in Cibalae, current Vinkovci. The purpose of this study was to evaluate the hypoplastic changes on teeth. The analysed sample consisted of the dental remains of 100 individuals with total of 2728 teeth. Enamel hypoplasia was commonly found in the observed sample, yet it appeared in a smaller number of teeth. Hypoplastic defects were more often found among the women, and were more severe - it can be assumed this is the result of a poor diet, and thus, a greater susceptibility to disease.

Keywords: Paleodontology; Enamel Hypoplasia; Vinkovci; Croatia

Introduction

The Roman town of Cibalae

Around 8000 years ago a settlement was established on the banks of the river Bosut in Croatia. This settlement became a significant Roman town. The continuity of Cibalae can be traced to the present day, in the form of the city Vinkovci (1).

The town got its municipal status in the time of the emperor Hadrian (117-138.), which suggests that the town must have had an urban character. The town of Cibalae was promoted to a colony with the emperor's decree at the beginning of the third century (2). A phase of stable development lasted until the dynasty of the emperor Constantine (305 – 363.), when Cibalae was in the period of its greatest prosperity and urbanisation. This period continued throughout the times of the Valentinian dinasty, which is known for its great public works and investments in the town. A lot of the buildings can be dated from the fourth century and a great deal of numismatic findings can be traced from this period. This phase lasted until 378 when, after the battle at Hadrianopolis, the system of provincial life in Pannonia broke down. The town underwent general crisis and depopulation and it can be assumed that life went on in smaller town areas during the fourth and the fifth century (3, 4). It is important to point out that two Roman emperors Valentinian I. (364-375) and Valens (364-378) were born in Cibalae (5).

The total area of the town was about 500,000 m2. It is assumed that during the peak of Cibalae it was inhabited by up to 10 000 citizens. Studies have revealed the existence of numerous facilities: town bathing, a decumanus, the main sewer, a granary, a number of kilns for ceramic and many other public and private objects (3, 4).

Paleodontology

Paleodontology is a part of bioarcheology which concentrates on studying features and pathologies of the stomatognathic system and the teeth of extinct populations. Paleoanthropological research can be directed into any field of dental medicine, from the growth and development of the stomatognathic system (6-10), through population specific dental characteristics (11-13), to pathological changes in the oral cavity which appear in the ancient populations, such as periodontitis (14-17), caries, periapical lesions (18-25), abrasion, orthodontic anomalies (26, 27) amongst others, to therapeutic interventions undertaken to achieve oral health (28). Hard dental tissue is one of the longest living physical traces of the existence of a human being after his death. As such it is a very good material for paleoanthropological research (29-32). The intensity and distribution of dental caries is studied on the skulls of ancient populations across long periods of time, which enables us to monitor economic, social and cultural changes during different historical periods (18, 20, 33, 34). Based on teeth and their pathology we can learn a lot about our ancestors, what they had eaten and what they had been doing for a living (35).

Enamel begins to form at the top of the tooth crown and continues to deposit evenly until it covers the entire crown, or until it makes the connection between the crown and the root. This can be disrupted during the apposition of minerals (mostly calcium and phosphorus) during embryonic tooth development. There are different factors that can slow down or even stop the process. Research has proved that the enamel is particularly sensitive to metabolic disorders which are usually a result of poor diet or disease. Nonspecific diseases that cause hypoplasia are: gastrointestinal illness in infants, severe infection, intoxication, influenza, scarlatina, measles, diphtheria, deficiency in vitamins A, D, C and hormonal diseases. Syphilis is the most important of specific diseases. Localization, extent and type of hypoplasia depends on the intensity, duration and time of noxae. Since tooth enamel has no remodelling ability, the developmental disorder will remain visible until the affected part of the crown is completely destroyed by abrasion. It is for this reason that disorders of tooth enamel can be a very useful indicator of physiological stress in archaeological populations.

The most common reported enamel developmental disorder in archaeological populations is linear hypoplasia. This is a quantitative defect that occurs due to the reduced thickness of enamel. The disorder is morphologically identified as one or more shallow horizontal lines on the crown of the tooth. Defects may manifest as yellow, creamy white, orange and brown lesions. Most hypoplastic defects are associated with systemic physiological stress such as starvation, infectious diseases, metabolic disorders and physical or psychological trauma. Therefore hypoplasia plays a major role in the reconstruction of the life of pastpopulations (36).

The aim of this study is to determine the prevalence,type and extent of hypoplastic changes in a dental sample from the Roman archaeological site of Vinkovci-Cibalae and to determine whether there is a statistically significant difference in the incidence of hypoplasia between men and women.

Materials and methods

The research was conducted on the skeletal remains of 100 individuals dating between the3rd – 5th century AD, excavated from the sites of: Kaufland, Makart, 2b Anina street, 7 Anina street and 48 I. Gundulića street, in the town of Vinkovci in period from 2007 until 2012 (3). The skulls used for this research are stored at the City Museum in Vinkovci, where they were analyzed. Before the beginning of the study each skull was assigned a unique identification mark consisting of the name of archaeological site and the number of grave. All recorded values of the observed parameters were recorded on a specially prepared registration form.

The presence or absence of enamel hypoplasia was registered for each skull, for all teeth in the sample. It was diagnosed with the unaided eye in daylight. The prevalence of hypoplasia was calculated as the percentage of people with hypoplastic teeth out of the total number of examined individuals.

Hypoplastic defects were classified into 6 groups (37):

0 - no hypoplasia
1 - horizontal linear defects
2 - vertical linear defects
3 - linear horizontal holes
4 - nonlinear rows holes
5 - individual holes

The expression of the enamel hypoplastic defects was classified into 3 groups (37):

1 - poorly expressed
2 - medium expressed
3 - strongly expressed
Prevalence of hypoplasia was tested with Chi-square test.

Results

The sample consisted of 78 adult skulls (51 males and 27 females) and 22 subadults (>15 years), Table 1. In the sample of 100 skulls, 3168 dental alveoli with total of 2536 teeth were examined.

A Chi-square test (X2 = 0,01) showed no statistically significant difference in the prevalence of enamel hypoplasia between males and females. A Chi-square test showed a statistically significant difference in the frequency of enamel hypoplasia on teeth between males and females X2 = 188,06, p <0,01.

The most commonly grade of enamel hypoplasia between subadults was grade 1, recorded in 72,7% of the cases. Between females the most common grades of enamel hypoplasia were grade 2 (43,4%), and grade 1 (43,0%). In the female sample, grade 3 was most common in females aged over 45 (18,3%). In the male sample 54,5% of cases with enamel hypoplasia had grade 1 hypoplasia. Grade 2 hypoplasia occurs much less in the male than female sample (24,2%) of the cases, but the grade 3 is slightly more common in males than females (21,4%), Table 3.

Discussion

The continuity of life in Vinkovci is reflected in the presence of all cultural phenomena that archaeologists recorded in area of central and northern Balkan from the Neolithic to the present day. The oldest date obtained by C14 method of dating is 6200 BC, so we can say that this area has been inhabited for around 8000 years (38).

The research data of pathological changes of stomatognathic system from this ancient European

nation, settled in the area of the present day Vinkovci, have been used for the reconstruction of lives of the people from Roman period. Skeletal remains of the stomatognathic system are the source of information about food, diseases, tools for work, the division of work in the community, ritual practices, and age of the death (39, 40).

The sample consisted of 100 skulls, of which 78% belonged to adults, and 22% to children under the age of 15 (Table 1.). Most of the people in the sample (61%) fell into the age group that encompasses a range of 15-44 years of age. The lifespan of the population may be shortened or extended depending on the socio-economic conditions of life. A shorter life span can indicate that a community lived in more difficult conditions (21).

Enamel hypoplastic defect were recorded on 39% of persons (per individual count) and on 27,5% of teeth (per tooth count). In the male sample 50,9% of males had enamel hypoplasia, although only 19,1% of the male teeth were affected with hypoplasia. It could be concluded that hypoplastic defects appeared often in the male sample but on a small number of teeth (mostly canines and incisors). Enamel hypoplasia in males was mostly expressed as grade 1 (54,5%).

In the female sample 44,4% of females had enamel hypoplasia, and 44,8% of the female teeth were affected with hypoplasia. As in the male sample, enamel hypoplasia appeared also in the female sample, but in the female sample the number of affected teeth was much higher. Grade 2 was the most commonly observed (42,2%) degree of enamel hypoplasia expression.

In subadults enamel hypoplasia was observed in 4,5% of cases, and on 9,9% of examined teeth. Subadults rarely hadhypoplastic defects and they were poorly expressed.

Enamel is sensitive to metabolic disorders that occur mostly because of poor quality of food and various diseases. Hypoplastic enamel defects are indication of stress in archaeological populations, which are a reflection of starvation, infectious diseases, metabolic disorders, and physical and psychological trauma.

It may be concluded that the ancient inhabitants of Vinkovci lived relatively healthy, especially children and men. In addition, it is possible that women may have experienced a poorer diet than men and were more susceptible to diseases and metabolic disorders.

If we compare the prevalence of hypoplasia in the Roman population from Cibalae with the prevalence in other populations from approximately the same area, but from different period (Table 4.), an increased prevalence of hypoplastic defects in samples from Vinkovci can be seen, with 48,7% vs. 14,1 % in samples from the Late Antique, and 14,7% in the sample from the Early Middle Ages. Also in the population of Cibalae smaller difference between males and females in the prevalence of hypoplasia was observed compared to two other populations.

Conclusion

Vinkovci, as a town which has been continuously inhabited around 8,000 years ago, is ideal for getting a great deal of information on population which inhabited this area throughout history. From the analysis of bone remains of 100 skulls excavated from more ancient sites (3rd-5th century) in the area of Vinkovci-Cibalae, it was found that 22 skulls belonged to the children and 78 skulls belonged to adults. Skull of adults in 51% of cases were male, and 27% of female. It may be concluded that the enamel hypoplasia was relatively common in people in the sample, but it occurred in a small number of teeth. It appeared on the much larger number of women's teeth as compared to men and children, and also it was much more pronounced among women and therefore we can conclude that women were worse fed and were more susceptible to diseases.

When we compared the population prevalence of hypoplasia from Cibalae with other populations that have lived on approximately the same area, but in late antiquity and the early Middle Ages, it was observed that there was an increased prevalence of hypoplasia of the sample from Vinkovci, and smaller difference between men and women in the occurrence of hypoplasia.

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Figure 1. Excavations at the archaeological site (by courtesy of mag. archeol. Hrvoje Vulić)

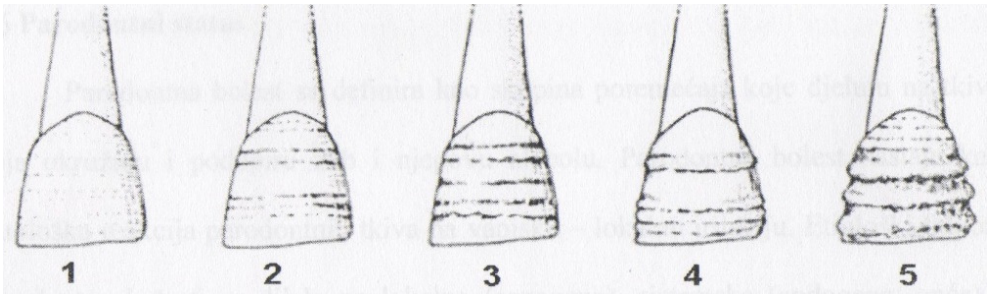

Figure 2. The degree of hypoplasia expression. From: Lukacs JR. Dental paleopathology: methods for reconstructing dietary patterns. In: Iscan MY, Kennedy KAR. Reconstruction of life from the skeleton. New York: Alan R. Liss Inc; 1989. p. 261-86.

Figure 3. Display of hypoplastic enamel defects

	Number of persons	Number of persons with significant enamel hypoplasia
Subadults	22 (22%)	1 (4,5%)
Males	51 (51%)	26 (50,9%)
Females	27 (27%)	12 (44,4%)
Total	100 (100%)	39 (39%)

Table 1. Number of persons with enamel hypoplasia

	Number of teeth	Number of teeth with hypoplastic defects	Number of teeth with no hypoplastic defects
Subadults	252 (100%)	25 (9,9%)	227 (90,1%)
Males	1489 (100%)	284 (19,1%)	1205 (80,9%)
Females	987 (100%)	442 (44,8%)	545 (55,2%)
Total	2728 (100%)	751 (27,5%)	1977 (72,5%)

Table 2. Frequency of enamel hypoplasia on teeth

		1	2	3	total
Subadult	**0-14**	16 (72,7%)	4 (18,2%)	2 (9,1%)	22 (100%)
Female	**15-29**	33 (40,7%)	36 (44,4%)	12 (14,8%)	81 (100%)
Female	**30-44**	29 (53,7%)	24 (44,4%)	1 (1,9%)	54 (100%)
Female	**45+**	43 (39,4%)	46 (42,2%)	20 (18,3%)	109 (100%)
Female total		105 (43,0%)	106 (43,4%)	33 (13,5%)	244 (100%)
Male	**15-29**	64 (52,9%)	33 (27,3%)	24 (19,3%)	121 (100%)
Male	**30-44**	52 (52,5%)	23 (23,2%)	24 (24,2%)	99 (100%)
Male	**45+**	80 (57,1%)	31 (22,1%)	29 (20,7%)	140 (100%)
Male total		196 (54,4%)	87 (24,2%)	77 (21,4%)	360 (100%)
Female and male total		301 (49,8%)	193 (31,9%)	110 (18,2%)	604 (100%)
Subadult, female and male total		317 (50,6%)	197 (31,5%)	112 (17,9%)	626 (100%)

Table 3. Display of the expression of hypoplasia

Sample		**Number of examined individuals**	**Individuals with hypoplasia**	**Prevalence (%)**
Late Antique (3rd–6th century AD)	**male**	76	16	21,1
	female	66	4	6,1
Late Antique total		142	20	14,1
Early Middle Ages (7th–11th centuries AD)	**male**	19	5	26,3
	female	15	0	0,0
Early Middle Ages total		34	5	14,7
Vinkovci - Cibale	**male**	51	26	50,9
	female	27	12	44,4
Vinkovci – Cibale total		78	38	48,7

Table 4. Comparison of the prevalence of hypoplasia with Vinkovci Cibalae sites (3rd-5th century) with the analyzed samples from Late Antique and the Early Middle Ages in continental Croatia