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OCCURRENCE OF THALASSEMIA MAJOR ON A PALEOANTHROPOLOGICAL FINDING

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Abstract

The sign of severe anemic alterations were found on a child-skeleton excavated in Székesfehérvár street in Pécs (South–Transdanubia, Hungary) from a 109 tombed late-Roman cemetery detail. The morphological observation, X-ray picture of the bone alterations, as well as the light- and electronmicroscopic study of the samples gave the diagnosis of thalassemia major.
Key words: paleopathology, Roman age, bone lesions of anemia, thalassemia major.

Introduction

Since the time of its first thorough observation and description (HRDLIČKA, 1914), the syndrome called „symmetric osteoporosis" is much better known. COOLEY et al. (1927) made observations that characteristic deformations appear on the cranial and skeletal bones of children suffering from thalassemia major. Followings this, several excellent reviews were published by hematologists and radiologists, the purpose of which was firstly to ponder over the type, severity degree and therapeutic possibilities of the anemic alteration on the basis of the bone deformations (CAFFEY, 1937; MOSELEY, 1963; ASCENZI, 1976). The obtained observations were successfully used and are used by the specialists dealing with paleopathology, too, and are also utilized in the more exact diagnosis of the alterations of the bones originating from different archeological ages (HOOTON, 1930; MOSELEY, 1965; ANGEL, 1964; HENGEN, 1971). From the recent publications, the other pathological conditions accompanying anemic bone lesions (metopism, enamel-hypoplasia) and the joint importance of these are discussed in a paper by STUART–MACADAM (1985), who investigated the hygienic conditions of a population from the Roman age.

In the meantime, the molecular mechanism of the development of the various anemic alterations (thalassemia, sickle cell anemia) had been clarified, giving possibility for closer approach to the better treatment of the cases occurring even nowadays (HOLLÁN, 1972; NIENHUIS et al. 1979).

For the paleopathologist it is of particular importance to emphasize the interdisciplinary nature of the research, since only the consideration of the activities of the hematologist, radiologist and geneticist can lead to the better clarification of each diagnostic problem.

Material and method

The Archeological Department of the Janus Pannonius Museum in Pécs (South-Transdanubia, Hungary) performed rescue excavations conducted by an archeologist, ZSUZSANNA KATONA Győr between 1981–83 in the inner town of Pécs at the site of a demolished building in Székesfehérvár street. 109 graves were found at the area from the late-Roman age. The excavated cemetery part belonged to the graveyard of the civic town Sopianae. The cemetery has not been described in an archeological publication so far. The skeletons were studied from paleopathological and partly anthropological point of view in 1983–84 (SZALAI, 1984). In the simple earth grave no. 106 the devasted skeleton of a child was found. One part of it had been destroyed in the Middle Ages during the digging of a pit. The following bones reamined: skull bones broken to several pieces, but partially restorable; both upper jaws and cheek, lower jaw. The eruption of every deciduous tooth was observable in the teeth row archs, but 6 of them were lost postmortally. The exchange of teeth had not yet begun. From the postcranial bones, the remaining ones were the right side of the atlas, the axis without dens and five cervical fractions, 6 dorsal vertabral archs and 2 vertebral bodies, furthermore, 30 smaller-larger rib fractions, both clavicle, the right-sided scapula, right-sided humerus, ulna and radius.

The sex could not be determined, because of the young age. On the basis of the dentition (SCHOUR and MASSLER, 1941) and taking the ossification table into account (SCHINZ et al. 1952), the age of death could be estimated between 2.5–3.5 years. Only a bronz coin furniture from the Roman Age was found in the oral cavity of the finding, which coloured the surrounding bones green.

Morphological alterations referring to generalized benign bone-marrow hyperplasia could be observed on the skeleton of the grave no. 106. Following the detailed macroscopic morphological description of them, the skull bones and the scapula were studied by X-ray as well. For electronmicroscopic study 5x5 mm sized, 2–3 mm thick slices were sawn from the pathological bone surfaces of the skull. Following soaking in 96% alcohol for one day and cleaning, the samples were steamed with gold layer in rotation apparatus, then studied under JEM 100 B scanning electronmicroscope on the basis of the experiences by HARSÁNYI et al. (1978). Samples taken from the macroscopically intact surface of the skull served for comparison. The photographs were prepared at a magnification of 1000x. After previous decalcination, sections were prepared from the bones for light microscopic studying, too.

Description of alterations

The alteration at first called „symmetric osteoporosis" has charasteristic, easily recognizable symptoms. The elemental phenomena of the alteration are formed by the followings: owing to the hyperplasia of the bone marrow occupying the fungous substance, the cortex becomes extenuated (Fig. 1a), then by dilating the physiologically also present small gaps the bone marrow reaches beneath the periosteum. By further spreading, the bone marrow strains the periosteum, which induces secondary bone formation along the dilated gaps. The septum-like, small bone increments protrude from the bone surface perpendicularly and construct a brush-like formation as observed in other cases, too (ASCENZI, 1976; MOSELEY, 1965).

These characteristic symptoms of benign marrow hyperplasia could also be determined on the skull and postcranial skeleton parts of the child skeleton from the grave no. 106. The alterations were detectable both on the ecto- and endocranial surfaces of the skull, firstly restricted to the frontoparietal region (along the tubera frontalia, squama frontalis, tubera parietalia, sutura sagittalis), but also on the squama occipitalis. At the mentioned places the smooth bone surface was found to be thickly pierced by roughly circular, small (with diameters of 0.5–1–2 mm), sharp

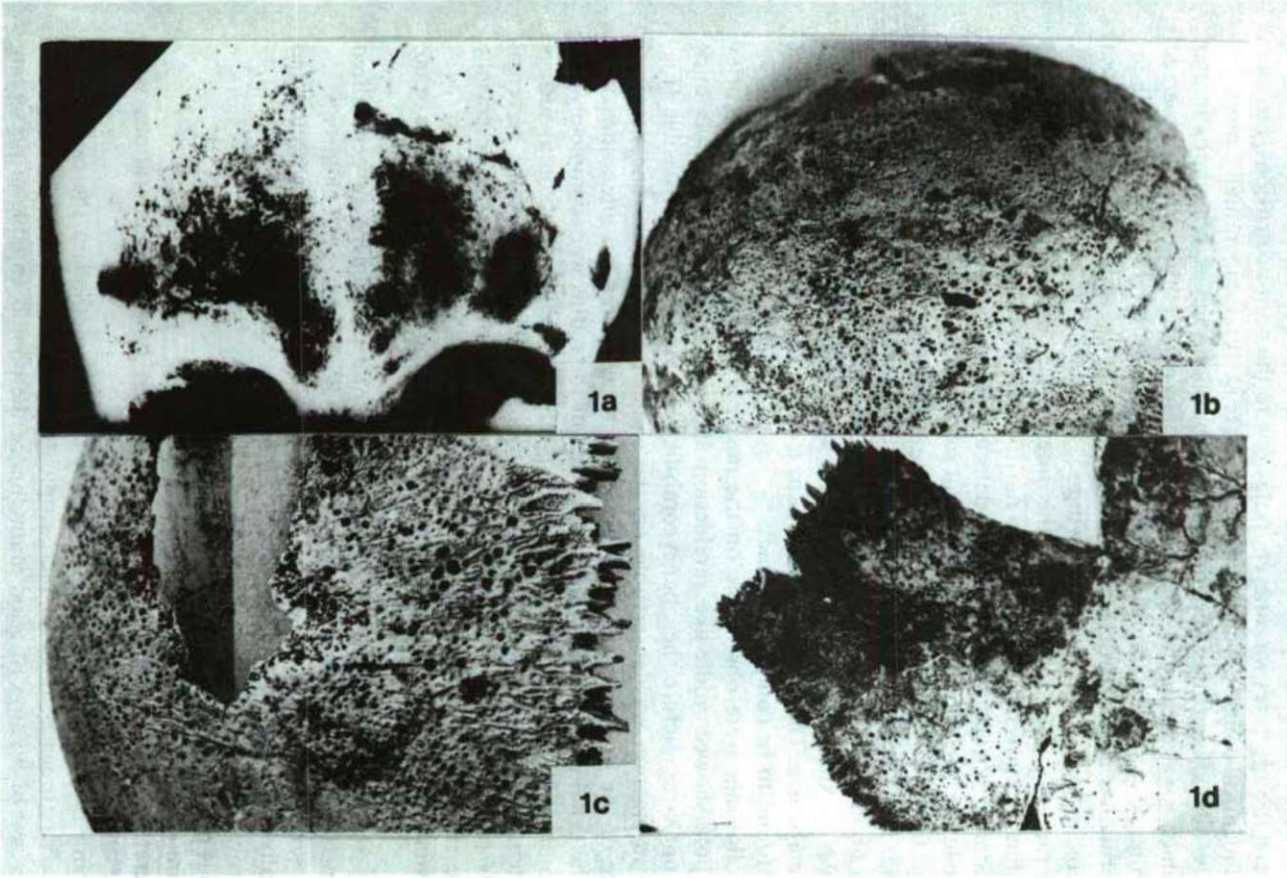

Fig. 1a. The expansion of the diploe space and the thinning of the cortex are well visible on the X-ray picture of the frontal bone
Fig. 1b. The ectocranial surface of the frontal bone with the signs of osteoporosis and hyperostosis
Fig. 1c. The ectocranial surface of the parietal bone with the formation of channels and passages
Fig. 1d. Moss-like, undulatory bone-laths are observable on the endocranial surface of the parietal bone

edged apertures (Fig. 1b). The brim of the apertures sharply protruded in a funnel-like manner at places, which made the bone surface rough to the touch. The space between the apertures was uneven, bulgy due to the brim-protrusions, furrows, passages of identical course developed on the vault (Fig. 1c). Endocranially, however, there not the dilated apertures were dominating, but bone-spines, bone-laths similar to moss, which have undulatory course (Fig. 1d). No rarefaction could be observed on the lamina frontalis bordering the orbit from above. Rarefaction and bone-increment formation could be detected on the corpus of the sphenoid, in the fovea hypophyseos, as well as on the greater wings.

Bone rarefaction was observed on the outer surface of both upper jaws of the skull, too, but the sinus maxillae were also narrowed down by long, sharp, spine-like exostosis. Similar porotic alterations were detected on the ascending ramus on both sides of the lower jaw, as well as on its mental section. The teeth are specially worth mentioning. Caries could be seen on the occlusal surface of all four second molar teeth (55, 65, 75, 85), probably also being in connection with the basic disease causing the lesions observable on the bones. The alterations affecting the teeth as well are presumptive of such a metabolic disorder which also had influence on the calcium-metabolism. The rest of the deciduous teeth and the germs of the permanent teeth were found to be completely intact.

The followings were observable on the postcranial skeletal bones: the cortex of the scapula showed riddle-like rarefaction and thinning, its spongy was thick (Fig. 2a), on X-ray picture the „honeycomb-like" structure was well visible (Fig. 2b). Bone rarefaction was observable on the ends of the clavicle. The proximal end-surface of the humerus was thin, spotted with apertures, no alterations were found at the distal part. The ulna and the cortex of the radius were completely free from symptom. The arch of the examinable vertebra as well as the frontal surface of the vertebral bodies were also found to be thinner. The height of the vertebral bodies was proportional, without any signs of compression. The ribs, especially around the angle, were thickened, deformed.

As a summary, the followings could be found on the skeleton of the grave no. 106.:

- very severe bone rarefaction with the elemental phenomena of generalized benign bone marrow hyperplasia on the bones of a 2.5-3.5 years old children;
- the same appeared on the skull with frontoparietal dominance (ecto- and endocranially);
- narrowed down sinus maxillaris;
- caries on all four second deciduous molars;
- cribra orbitalia could not be observed;
- alteration was more characteristic on the flat bones, no alterations were observable on the surfaces bearing the cartilage.

Scanning electronmicroscopy (SEM) is a suitable method in the cases when surface studies are necessitated in microscopic dimensions.

In the case of findings of good maintenance the bone is capable of preserving the alterations originating from disease, injury for as long as several thousand years,

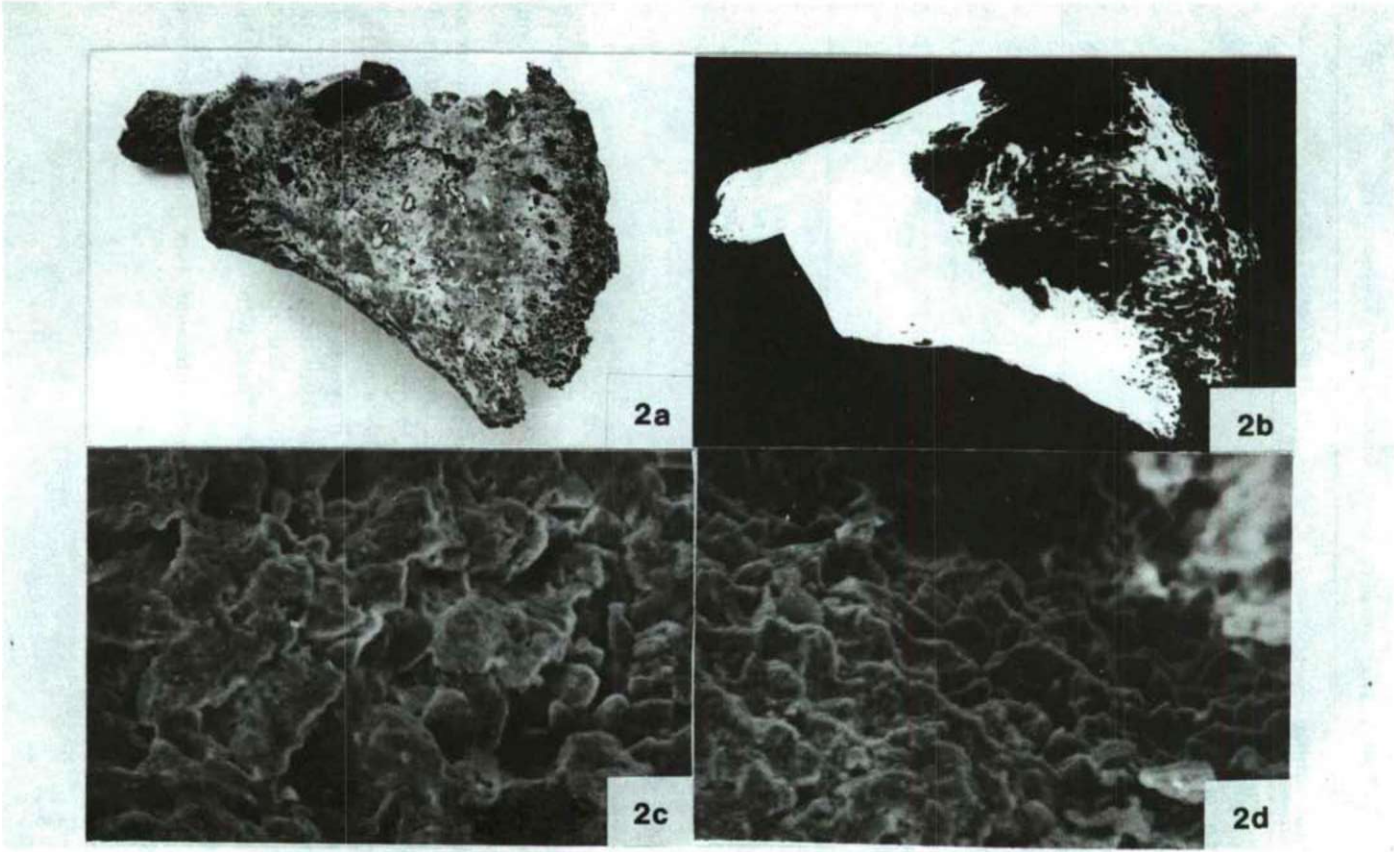

Fig. 2a. Porotic facies costalis of scapula
Fig. 2b. „Honeycomb-like" contour is recognizable on the X-ray picture of the scapula
Fig. 2c. SEM picture of osteoporotic skull surface with lump-like ossificational centres (1000x)
Fig. 2d. Small, conoidal exostoses are detectable on the SEM picture of intact skull surface (1000x)

Table 1. Symptoms of diseases causing bone marrow hyperplasia

Symptoms, characteristics	Types of diseases						Grave no. 106
	1.	2.	3.	4.	5.	6.	7.
Below 5 years of age	+	+	+	±	±	+	+
Severe bone lesions	+	+	–	–	–	–	+
Frontoparietal skull deformation	+	+	+	–	+	+	+
Occipital skull deformation	–	–	–	+	–	–	–
Presence of cribra orbitalia	±	±	–	+	–	–	–
Deformation of cheek	+	±	–	–	–	–	+
Narrowed down sinus maxillae	+	–	–	–	–	–	+
Disorder of postcranial bones	+	+	±	±	–	+	+
Bone-infarctions following thrombosis	–	+	–	–	+	–	–
Vertebral body compression	–	+	–	–	–	–	–
Bone deformation around the elbow-joint	–	–	–	+	–	–	–
„Honeycomb-like" bone structure on X-ray picture	+	–	–	–	–	–	+

Explanation of labellings :

+ the observed characteristic occurs
± the observed characteristic may be rarely occur
– the observed characteristic does not occur

The names of the diseases-types no.1.–6. see in the text.

even at microscopically. This gave the notion to perform SEM studies on bones originating from archeological excavations (HARSÁNYI, 1977; MARCSIK et al., in press).

SEM studies were also carried out on the sample sawn out of the osteoporotic surface of the parietal from the grave no. 106. On this basis it could be determined that apertures dilated in funnel-like manner led to the bone surface from the direction of the diploe, and in these the hyperplastic bone marrow was pushed beneath the periosteum. Due to the periosteal irrigation, irregular shaped, lump-like centres of ossification were detectable on the bone surface between the apertures (Fig. 2c). On a picture of the same magnification, only pin-pricked apertures led to the surface on the sample taken from the intact surface. These were made finely uneven by small, conoidal exostoses (Fig. 2d).

The observed phenomena indicated the trabecular type of the alteration (MARCSIK and KÓSA, 1976).

Discussion

The amount bone marrow increases in every case when the oxygen demand of the tissues is considerably and long-lastingly greater than that of the erythrocytes can provide. The decrease in the average life span, or the pathological hemoglobin content of the erythrocytes, furthermore, their vitamin B_{12} and iron deficiency all lead to compensatory bone marrow proliferation. This compensates the hypoxia of the tissues with enhanced erythropoiesis. In infancy and early childhood the enhanced erythropoietic function is taken over by the enlarged liver and spleen as well as by the overgrowing bone marrow found in the spongy of the skull and the other bones. The question is, which diseases in childhood may lead to bone marrow hyperplasia accompanied by enhanced erythropoiesis?

Taking the opinion of MOSELEY (1965) into account the following diseases may be considered to be important:
1. thalassemia major. 2. sickle cell anemia, 3. hereditary spherocytosis, 4. iron deficiency anemia, 5. heart diseases accompanied by cyanosis, 6. polycythemia vera.

The alterations characteristic of the various diseases are summerized in Table 1. on the basis of reference works (MOSELEY, 1965; ASCENZI, 1976; STEINBOCK, 1976). The serial number 7. indicates the child skeleton under discussion. The table also demonstrates the lack or presence of a character in diseases already known and labelled by previous serial numbers, as well as in the case of the bone deformation of the grave no. 106 of unknown origin.

On the basis of the described morphological phenomena and the comparison with other diseases, the pathological alteration of the skeleton from the grave no. 106 excavated in Székesfehérvár street in Pécs can be diagnosed as thalassemia major. Apart from the morphological signs, the geographical-hematological data also refer to thalassemia. The finding originates from the Roman Age for certain, and according to archeological data (FÜLEP, 1969) there were also families among the inhabitants of the town Sopianae, who had settled down here from Italy. The homozygote form of thalassemia is known both from historical ages as well as in the populations of today, firstly from the region of the Mediterranean.

Our case proves that the paleopathological studies may provide data to the clarification of a population's migration, too.

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