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Endocranial lesions and interpretation of their cause in the modern population from Wrocław, Poland

Abstract

Lesions observed on the inner surface of the cranial vault, such as abnormal blood vessel impressions (ABVI), periosteal appositions of the dura mater (PADM), and arachnoid fossae (AF), closely related to processes occurring within the meninges, are considered useful indicators for assessing the health of historical populations, with particular emphasis on infectious diseases and scurvy. However, because these changes are not pathognomonic for any disease, their interpretation remains challenging. Furthermore, these changes are often overlooked in paleopathological analysis due to their location and limited access.

ABVI and PADM can result from traumatic bleeding or spontaneous bleeding associated with vascular pathology, including metabolic disorders leading to weakening of the vascular walls (as in scurvy). Meningitis, caused by infections, may also be a contributing factor. The formation of AF is caused by pressure from arachnoid granulations (AG) on the inner surface of the cranial vault. They are not considered pathological, but their size and number typically increase with increased intracranial pressure, which may accompany inflammation within the meninges.

The primary objective of this doctoral thesis was to investigate the potential utility of endocranial lesions (ABVI, PADM, and AF) in paleopathological assessment, to characterize their morphology, and to identify their etiology, with a particular emphasis on infectious diseases, scurvy, and their co-occurrence. A further aim was to investigate whether the area and number of AF are associated with the occurrence and severity of ABVI and PADM lesions, and whether they can indirectly indicate the presence of inflammation within the meninges.

The research material consisted of an osteological series excavated from the modern Our Saviour Cemetery (16th–19th centuries AD) located on the outskirts of former Wrocław. The population buried within the necropolis varied in socioeconomic status, with individuals from the lower social classes of the Wrocław area also buried there. Both archaeological and historical data suggest that victims of epidemics that occurred in Wrocław at that time were also buried there. The skull vaults were examined using a technical endoscope. The frequency and severity of ABVI and PADM were determined, and the AF area was measured based on scaled images. Additionally, an analysis was conducted of paleopathological lesions observable in the skull and postcranial skeleton, particularly those associated with scurvy and infectious diseases. Genetic studies were also conducted, selecting individuals with inflammatory lesions on the ribs and endocranial lesions (ABVI and PADM). To

confirm the presence of ancient DNA (aDNA) of selected pathogens and to identify diseases affecting the inhabitants of modern Wrocław, 23 molars were selected and used in molecular analyses. A high incidence of endocranial lesions associated with ABVI and/or PADM (53.5%) and lesions probably related to scurvy (47.9%) was demonstrated in individuals from the Our Saviour Cemetery in Wrocław, as well as a correlation between the occurrence of PADM and a probable diagnosis of scurvy ($\chi^2 = 8.96$; $p = 0.003$). Furthermore, individuals with ABVI had a larger AF surface area (Me = 1.97 cm²; IQR = 1.81) than individuals without these lesions (Me = 0.96 cm²; IQR = 1.52). Molecular testing confirmed the presence of *M. tuberculosis* in the collection of skeletal remains, thus confirming the presence of tuberculosis victims at the Our Savior Cemetery. Thirteen of 17 (76.5%) examined individuals were identified as infected with *M. tuberculosis*. Scurvy associated with *M. tuberculosis* infection was recorded in nine cases (52.9%).

The study demonstrated that the presence of ABVI, PADM, and AF surface area could be additional diagnostic criteria for infectious diseases causing meningitis in paleopathological analyses. Because ABVI and PADM are nonspecific, these changes should not be seen as direct indicators of specific diseases but rather as prompts for further research, including detailed genetic and/or histological studies. It is important to note that the results do not exclude the possibility of coexisting scurvy and infectious diseases. Additionally, a method for examining endocranial lesions with a technical endoscope was developed, and a morphological classification of the different severity levels of the examined lesions (ABVI and PADM) was outlined. The study also proposed clarifying the terminology related to lesions associated with periosteal appositions of the dura mater (PADM). Furthermore, it confirmed the practice of burying tuberculosis victims at Our Saviour Cemetery in Wrocław.