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Diagnosis of multiple osteomas in an ancient skeleton discovered in the necropolis of Caravate - Northern Italy

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Summary. *Background and aim of the work:* A great number of neoplastic lesions are reported in paleopathological literature, in different periods and geographic areas; this is a proof that numerous tumors affected past populations. In particular, osteoma is a lesion that is familiar to paleopathologists. Nevertheless, the presence of multiple osteomas is poorly documented in paleopathological records. The aim of this paper is to report a pathological condition of multiple osteomas found in an ancient skull unearthed in the medieval necropolis of Caravate (Varese-Northern Italy). *Methods:* The classical physical anthropological methods were used for the macroscopical identification (race, sex, age at death and stature) of all the skeletons recovered by archaeologists. Biological identification of the skeleton followed guidelines recommended in Buikstra & Ubelaker (1994). *Results:* Radiological exams allowed to discover compact dense and uniform areas of thickening in the skull of Tomb 1, normally associated with Gardner's Syndrome. The characteristic of this illness is the advancement of hundreds to thousands of intestinal adenomas (familial adenomatous polyposis, FAP), which can cause the development of colon or intestinal cancer. *Conclusions:* Paleopathology documented that benign and malignant tumors were present since the Neolithic. The scarcity of paleopathological cases of multiple osteomas reveals the necessity for more extensive research on paleoncology, through the systematic analysis on human osteological collections. To better understand possible case of Gardner's Syndrome, it would be useful to extend the analyses to all other skulls from the skeletal remains of the necropolis.

Key words: multiple osteomas, Gardner's Syndrome, X-ray, Computer tomography, Caravate, Italy

Background

The study of ancient human remains shows that many present-day diseases affected man in the past. Paleopathological investigations are important for two reasons; firstly to discovery the illness present in the past and secondly to study disease processes which afflicted the lives of early man (1). In several osteoarchaeological studies, tumours have been identified in mummies and in ancient bones: angiomas, meningiomas, osteosarcomas and osteomas. However, the interpretation of neoplasm in ancient human remains is one of the most difficult aspect of paleopathology for a number of reasons. Limitations are set by paleopathological materials which consists of osseous remains; post-depositional bones alterations, such as chemical factors (for example soil acidity), physical agents (mechanical erosion) and other biological factors, can be confused with typical osteolytic lesion of primary and metastic bone lesions (2). Another limitation to the paleopathological interpretation of tumors in antiquity is that many neoplasm conditions are often not visible macroscopically in the skeleton and frequently can only be identified with the aid of radiological and histological analyses (3).

Nonetheless, the identification of malignant tumours in early skeletal remains is possible even if signs of bone proliferation are minimal (4, 5). While, for benign tumours the lesions are characterised by slow growth rates, a round or oval form, a separate margin

between affected and non-affected tissues (2, 3, 6, 7). The osteoma, benign bone tumour that is most asymptomatic and arise from well differentiated mature bone tissue, is a lesion that is familiar to paleopathologists (2, 8). In particular the "button osteomas", smooth-surfaced and circular protrusions with demarcated margins, which are macroscopically visible (9). While the paleopathological record of multiple osteomas is scarce because it is a very rare pathological condition and because it is difficult to identify it only with macroscopical examinations (10).

In this paper, we report a case of multiple osteomas of a medieval skull and we discuss its differential diagnosis and pathology. The final goal is to integrate both clinical and paleopathological diagnostic criteria and to consider the most common limitations to the study of multiple osteomas within human remains.

Methods

The skull under examination in this study corresponds to tomb 1 of the necropolis of Caravate (Varese-North Italy). The medieval necropolis of St. Agostino was excavated by the Archaeological Lombardy Society between 2002 and 2003 (11). The cemetery report of St. Agostine Church describes a complex of sixteen tombs in structured recesses and closing stone slabs, aligned with each other and arranged in an East-West-facing cephalic end. The remains of buried skeletons were found in a supine position. The stratigraphic reconstruction, as well as the tomb structure, demonstrate that burials are datable around 8th or 9th century AC. These archaeological documents are really important because they help us to study the funeral and the burial practices used in this period (12).

The recovered skeletal remains are presently housed at the Center of Research in Osteoarchaeology and Paleopathology of the Insubria University. The first anthropological investigations were necessary to rebuild the paleobiology of the little medieval population of Caravate (9). These bones belonged to twenty individuals, fifteen which were reassembled in their skeletal districts.

The considerable presence of traumatic stigmata on some subjects led our successive research to carry a more specific analysis employing Diagnostic Imaging and more specifically X-ray and CT scans that allowed us to understand the extent of the lesions.

Age and sex of the skeleton of tomb 1 are estimated not only based on pelvic and cranial morphology, but also according to standard methodology. More precisely sex estimation has been estimated following the guidelines outlined by Buikstra and Ubelaker (13); while age estimation was based on the degree of cranial suture closure, on the morphology of the pubis symphysis and of the auricular surface of ilium. Long bone lengths, instead, were measured following Martin and Saller (maximum length in all cases) (14). Finally, in order to give a determination of stature we used Trotter and Gleser method (15).

We utilized conventional medical radiological equipment, specifically an 16-layer X-ray (Eclos 16, Hitachi Medical System). The scan parameters of the X-ray beam were 100 kV and 150 mA. The slice thickness was 1,25 mm. Images data were transferred to an advantage window workstation to perform 2D and 3D reconstructions. In order to analyse the skull, the window width (WW) was 0 and the window level (WL) 4800.

Results and discussion

In the tomb 1, there is adult skeleton. The female gender was determinated by observing pubic and cranial morphological traits. Through the evaluation of degenerative changes to the joints and vertebrae, and thanks to some significant closure of ectocranial and palatine sutures, we could establish that the individual was aged approximately 40-50 years old. The woman was between 1,50-1,55 meters tall. The cranium conserve only the portions of the frontal, the parietal and the occipital bones and it exhibits a small quadrangular perforation on the right frontal (16). This lesion was perhaps caused by a pointed weapon with a pyramidal trunk head (figure 1). The skull has been transported to the Institute of Radiological Diagnostics of the Fondazione Borghi in Brebbia for X-ray and CT examinations. Radiographic examinations indicated that the trauma occurred when the subject was alive and unexpectedly revealed compact dense and uniform ar-

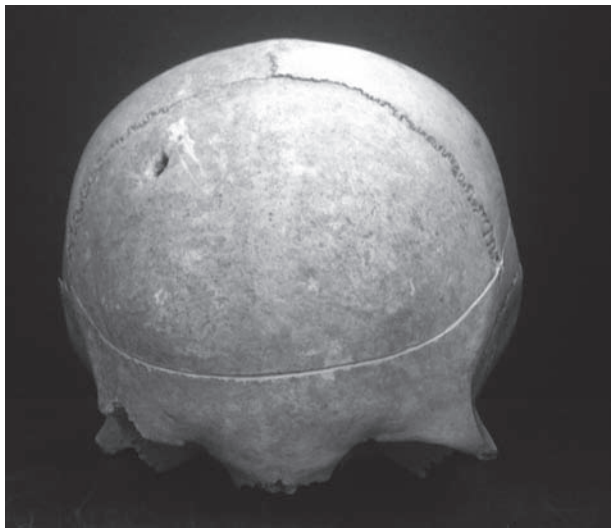

Figure 1. Skull of tomb 1, Caravate necropolis.

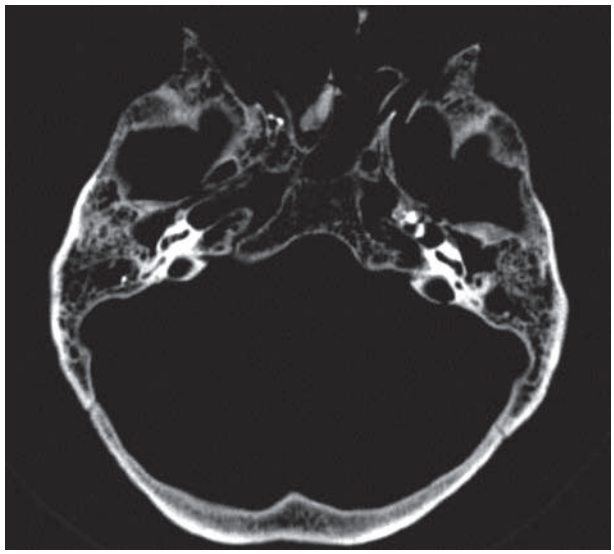

Figure 2. CT images shown areas of structural thickening compact dense and homogeneous, with net margins and peripheral rim radiolucent, localized in the right sphenoid sinus, ethmoid cells in the rear of the left and the apex of the petrous left.

eas of thickening (figure 2). The clear edges, a radiolucent peripheral rim located in the right sphenoid sinus and some ethmoidal cells in the rear left petrous apex allowed us to see multiple osteomas. It is difficult to contradict radiology diagnoses of craniofacial osteoma presenting as dense and compact clumps consistent with clean edges and radio transparent rims. Therefore, the osteomas diagnosis is clear. Osteoma is a benign neoplasm characterized by slow growth that clinically affects the long and cranial bones, and histologically display the proliferation of either compact or cancellous bones. It may occur in endosteal or periosteal surfaces, with considerable size variations. Osteoma develops mainly in the head and in the neck regions, which includes the facial bones, skull and mandible, and it is the most common benign tumor of the sinonasal tract. The location of osteoma in the occipital region is extremely rare. The osteoma facial skull is quite asymptomatic, to the point of altering sinus drainage and sinusitis or deforming the walls of the orbits and protruding under the oral mucus.

The occurrence of multiple osteomas is a very rare condition. However, the literature examines different hypotheses with regard to their formation, including the idea that the lesions may be caused by congenital anomalies (17) or that chronic inflammation may originate within neoplastic proliferation (18). The development of osteomas may also be a consequence of trauma or embryogenetic changes. Multiple osteomas can be observed, for example, in the setting of hereditary adenomatous polyposis coli (APC) related to Gardner's Syndrome (GS). The hallmark of this disease is the development of hundreds to thousands of intestinal adenomas (familial adenomatous polyposis, FAP) which eventually leads to the development of colon or intestinal cancer (19, 20). In 1952 Gardner and Plenk explained that the prevalent hereditary pattern of multiple osteomas were connetted with colonic polyposis. One year later, Gardner and Richards reported that the association of multiple cutaneus and subcutaneous lesions, with hereditary colonic polyposis and osteomatosis, completing the description of the clinical syndrome that has come to bear Gardner's name (21, 22). In our case, without viscera or organs, the diagnosis of Gardner's Syndrome cannot be confirmed. Today we know that Gardner's Syndrome is a rare genetic disorder characterized by hereditary intestinal polyposis, osteomas and tumors of soft-tissue (23). GS originates from the mutation of the adenomatous polyposis coli locus (APC gene) located in chromosome 5q21-q22, and, as a genetic disorder, it could be diagnosed with the DNA investigations, even if it is important to consider that, in paleopathology, the use of ancient DNA (aDNA) is difficult (24). Then, to complete our

investigations and to highlight the possible diagnoses of FAP with extra colonic features, it would be helpful to extend the radiological investigation to all skeletal remains buried in the Caravate necropolis.

In an archaeological context, a sure diagnosis is one of the more satisfying aspects of osteoarchaeological research, especially when bones are scarce (25-27).

Conclusion and perspectives

Rarely is it easy to diagnose the osteoma on ancient skeletal remains. In fact, the identification of osteoma depends on the state of preservation of the skeleton. Moreover, this pathological condition is difficult to diagnose without radiological and histological examination of the bones.

In our osteoarchaeological collection, we have found osteomas on some skulls. In particular, there are two interesting cases from the site of Sarigo, Varese (figures 3, 4). One of these skulls has two small neoformations related to frontal osteomas, while the other one has frontal osteomas in the left coronal suture. The partially mummified skull unearthed from an excavation of the Sacro Monte (Varese) is notable. Investigations allow us to diagnose two small osteomas in the frontal region.

The few paleopathological records we have indicate that benign and malignant tumors have been present in human population since the Neolithic. The

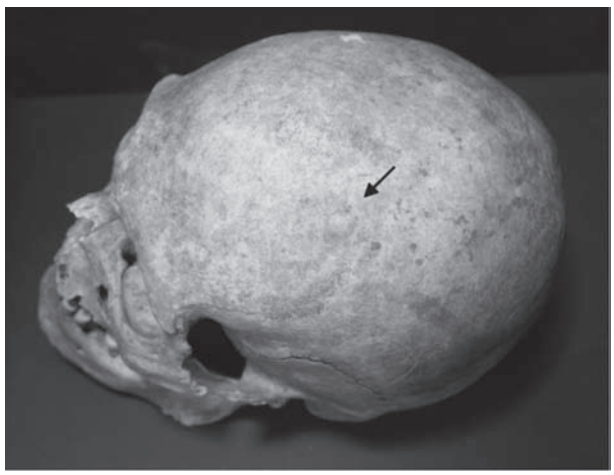

Figure 3. Skull from Sarigo necropolis that shows a button osteoma.

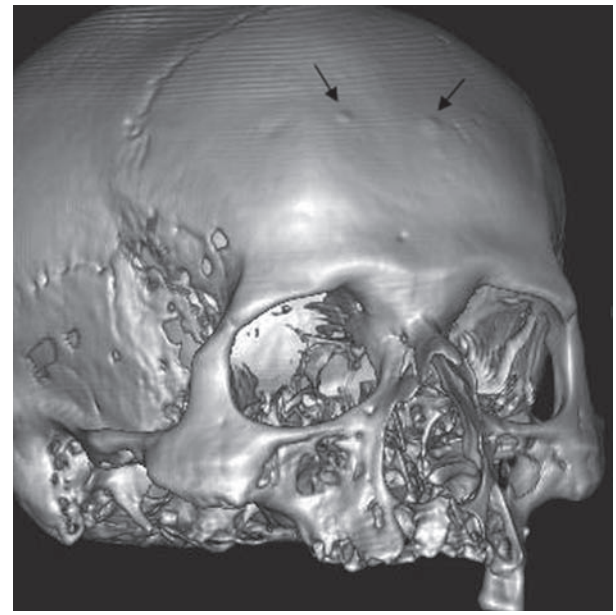

Figure 4. CT images of a skull from Sarigo necropolis. We can note several osteomas on the frontal bone.

shortage of paleopathological cases of multiple osteomas reveals the need for more extensive researches on paleoncology, through the systematic examination on human osteological collections. The adult female individual in tomb 1 shows a paleopathological proof of a multiple osteomas condition in the past. Despite the detailed description and the diagnosis radiologically performed for this skeleton, it was not possible to propose the idea that this is caused by the Gardner's Syndrome. We can only suppose that, during life, this individual may have been asymptomatic, although there may have been some localized pain or swelling. In relation with the age at death estimation of our skeleton, compatible with the medial survival of the individuals with FAP, we might suppose that Gardner's Syndrome was the cause of death. However, it is important to consider that, in the past, the life expectancy was shorter than now.

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