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Articoli/*Articles*

HISTORY OF MEDICINE AND PREHISTORIC ORTHOPEDICS

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SUMMARY

Increasing efforts have been recently made to apply medical technologies to history of medicine of ancient time. Despite the use of molecular biology techniques, the most reliable results have been obtained by the paleopathological study on disease which may recognized by the observation of stigmata *of bones: the datation of skeletal lesions and the findings of cranial and orthopedic lesions indicate that the attempts of cure of bones are typical of early medical activity, dating from the prehistoric antiquity.*

History of medicine of ancient time may receive important contributions by both the analysis of the correspondance of biological data to ancient medical events as described in medical literature[1] and the paleopathological findings. This latter field has been explored mainly by the analysis of lesions of bones, as markers of pathological conditions[2]: although efforts have been made to apply biological and molecular analyses to ancient bones, i.e. DNA characterization, many methodological difficulties (i.e. microbiological contaminations) make uncertain the results which have been obtained. Thus, traumas are cer-

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tainly one of the most well known ancient pathologies and we have direct evidence of skeletal traumas, especially fractures, that are hundreds of thousands of years old[3]. The bones of the most ancient representatives of our genus, *Homo,* display traces of traumas. For example, among the *Homo erectus* bones found on the Island of Java (formerly identified as *Pitecanthropus erectus)* in the last century (1891) by the Danish physician E. Dubois[4], there is a femur with a large post-traumatic exostosis on the internal face of the middle third of the bone (Fig. 1).

To even attempt to list the fractures and outcomes of the skeletal traumas found among the remains of prehistoric men would be impossible given the quantity of cases described in the literature, and many reviews may be useful for a preliminary approach[2-3].

Because of their number and variety, one can use these remains to examine both the diseases themselves (type, frequency, topographical distribution, epidemiology, and trauma-

Figure 1. - The well known Dubois Femur from Java, attributable to *Homo erectus,* which displays a large, probably post-traumatic exostosis.

related complications), and the therapeutic measures adopted by our ancestors to encourage the healing process, as well as to relieve the suffering of the victim.

In this paper we shall limit ourselves to the latter topic, in other words the earliest record of orthopedic and traumatological therapy.

Through the study of ancient skeletal remains, we may be able to document bone traumas and their outcomes from all periods of history and throughout the world. Indeed, it has been repeatedly demonstrated that the frequency of skeletal trauma has decreased markedly over the past few thousand years, though there are many exceptions to this general trend[5].

The most striking fact to emerge from the study of ancient human skeletal remains, however, is not the high frequency of fractures, which one would expect considering the considerably more active life styles of the past, but the great number of healed fractures. This healing already occurred in extremely ancient communities. For example, the archaeological site of Shanidar, in Iraq, has yielded the skeletal remains of a community of Neanderthals; a considerable percentage of the individuals had suffered skeletal traumas, which were frequently multiple. However, the traumas were never the direct or immediate cause of death. Indeed, all the cases examined clearly show that the victim had healed (in some cases with a complete *restitutio ad integrum*) by the time of death. It is also surprising that the healing of the fractures generally occurred without complications; in only one case was clear evidence of a secondary infection observed. We have no evidence that will allow us to confidently correlate the observations mentioned above with specific therapeutic practices. It would in any case seem improbable that the splinting of fractures was known and practiced at such an early date (the site dates to about 50,000 B.C.). On the other hand, it is equally clear that many of the traumas observed required at the very least long periods of immobility to heal. It is therefore evident that Neanderthals cared for their sick, allowing them to lie still and seeing to their needs. This may be the earliest direct

evidence (based in other words on the study of skeletal material) for the practice of *general medicine* in prehistoric antiquity.

Dastague discusses a clear example of this, in his treatment of the skeleton of an adult female from the mesolithic community of Columnata, in Morocco[6]. The woman, who lived about 10,000 years ago, suffered an extremely severe trauma of the pelvis in which her sacrum was crushed; the injury undoubtedly caused the paralysis of her lower limbs. The radiographic examination of her remains has shown that despite her immobility she survived the incident at least long enough for her multiple fractures to heal. The survival of people injured this seriously at a time in which the ability to cover great distances on foot and to hunt were truly vital, shows that there was a social organization in which the community cared for the infirm.

Shortly thereafter, however, men realized that they could do more than just guarantee the survival of their injured companions; indeed, they could relieve the suffering of the injured and hasten their healing.

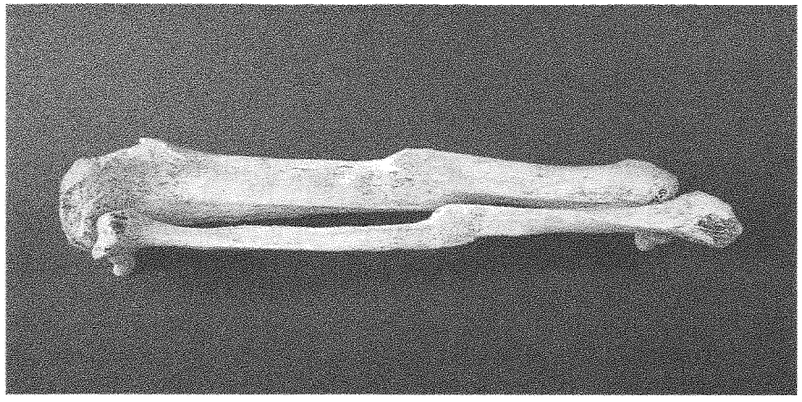

Figure 2. - Limb bones of an adult male from the Iron age necropolis of Alfedena, L'Aquila, Italy. Traces of a complete transverse fracture of the tibia and fibula that was treated by approximately aligning the ends of the bones, and which subsequently healed completely, are evident.

Egyptian physicians were undoubtedly quite familiar with splinting, which they practiced using strips of tree bark, canes, or rigid sticks that they tied firmly to the affected limb with cloth bandages[7]. In some cases, these methods of external splinting have been preserved. For example, several subjects have been found who happened to die while they had immobilized limb fractures, and were mummified with their orthopedic apparatuses in place (specimens at the Museum of Anatomy of the College of Medicine and Surgery of the University of Cairo).

The application of sticks to immobilize broken limb bones was certainly practiced in prehistoric Italy. Among the Iron age skeletons found in the Alfedena Necropolis (Aquila), one was found with a complete fracture of the lower limb (Fig. 2). The fracture, which affected the middle third of the diaphyses of the tibia and fibula, healed completely without complications; the limb is slightly shortened and displays signs of having been externally splinted, though the ends of the bone were only approximately aligned[8].

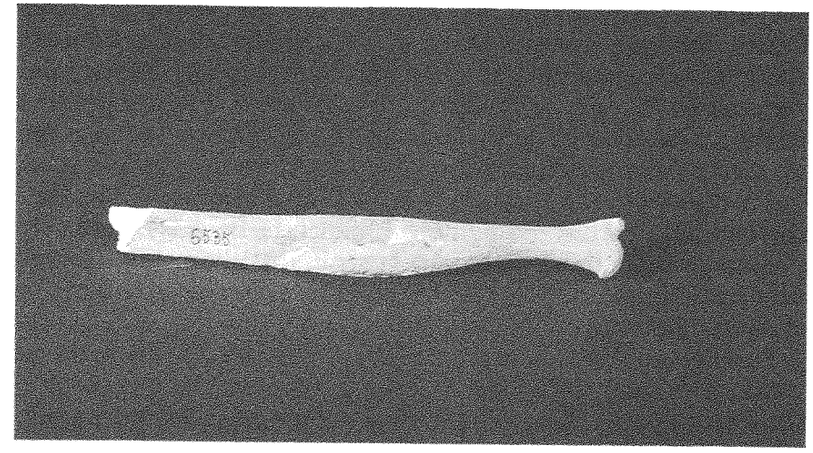

Figure 3. - Bronze age ulnar fragment from the Grotta dello Scoglietto, Grosseto, Italy, which displays traces of a fracture that may have been surgically set.

Today we know that the surgical treatment of fractures also began at an early age; the earliest known cases are datable to the Bronze age, and have been found in Italy[9]. The prehistoric Grotta dello Scoglietto (Grosseto) has yielded abundant human skeletal remains datable to the early Bronze age, including the distal fragment of an ulna (find N° 6535), which underwent a transversal fracture, with the formation of an osseous callous. The general appearance of the specimen (Fig. 3) and its x-ray suggest a surgical reduction of a diaphysary fracture[9].

Passing on to more recent periods and materials, in both the Classical Greek and the Ancient Roman worlds people were familiar with and practiced effective therapies for all forms of trauma, including fractures. The people who treated traumatic diseases were for the most part the leaders of the gymnasiums in Ancient Greece, and the physicians who were present in all the gladiatorial schools and gymnasiums of Imperial Rome.

Cato states that fractures of the limbs were immobilized using splints made from green reeds that were at least 5 palms long[10]. In addition, both the Greeks and Romans resorted to surgery in some cases. It was worth noting that Aulus Cornelius Celsus, the noted Roman writer of natural sciences (1st Century B.C.), including medicine, was perfectly described the surgical reductions of every kind of fracture: its work was not present in the summaries of medicine made by epitmists, because the *De Medicina* languished in obscurity for 15 centuries before being re-discovered in Milan in 1443 and reprinted in 1478 by Bartholomaeus Fontius; the eighth volume of the book is completely dedicated to orthopedics, and contains brilliant, exhaustive descriptions of many surgical techniques for the treatment of skeletal traumas.

Further confirmation of the expertise of the ancients at treating trauma comes from the archaeological excavations of the Roman cities of Herculaneum and Pompeii; they have yielded an enormous number of objects, including several scalpels, many of which were certainly used in orthopedic surgery, and perfectly match those described by Celsus.

Nor is the modern practice of applying internal fixation, for example attaching screws or metal plates to reinforce surgically reduced fractures, a modern technique. To date, three cases in which metallic plates were applied to ancient bones have been described in the literature; in all three, the bone affected was the humerus, and the plates were made of copper.

The first case involved a skeleton found in the Saxon cemetery of Both Sides, in England, and has been dated to the Norman period, around the 13th Century A.D. The plate was made of almost pure copper, and was applied to the center of the humeral diaphysis. The bone displays obvious traces of chronic osteitis and periosteitis, with the formation of osteomyelitic sinuses and cloacae which were in part hidden by the plate. By the time of death, the inflammation must have passed, because the bone sequestrae reveal traces of scarring[11].

The second case involved a subject whose skeletal remains were excavated from the Cistercian Abbey of Varnhem, in

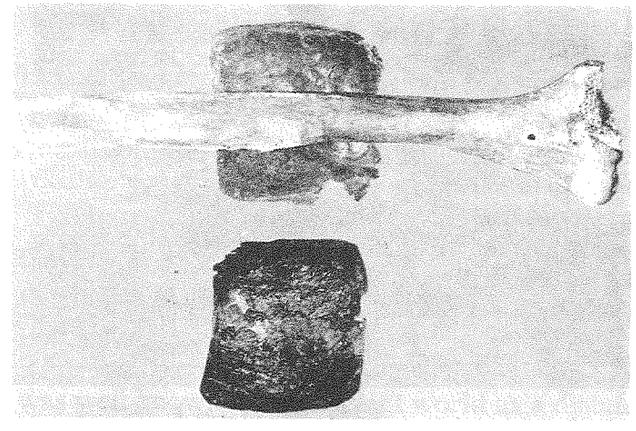

Figure 4. - Copper plate applied to a humerus from Saxon cemetery, dated to about the 13th century A.D. (from Wells, 1964).

Sweeden, and which have been dated to between 1260 and 1527 A.D. The plate is made of extremely pure copper, and surrounds the humerus at the point between the lower and middle thirds of the diaphysis. It was attached to the bone with several pins that were lost in the course of the skeleton's long burial (Fig. 5). In this case too, traces of exostoses were found both below and around the periphery of the copper plate; the condition may have been caused by a periosteal inflammation[12].

The third case involved a subject who lived between 1579 and 1650 A.D., whose remains were excavated from the Cathedral of Vrasene, Belgium (Fig. 6). In this case the plate (Fig. 7) was wrapped tightly around the entire middle third of the humeral diaphysis, which shows no traces of any sort of pathological condition (not even exostosis)[13].

Despite the scantiness of the material, it appears evident that the copper plates applied in Northern Europe in the high Mid-

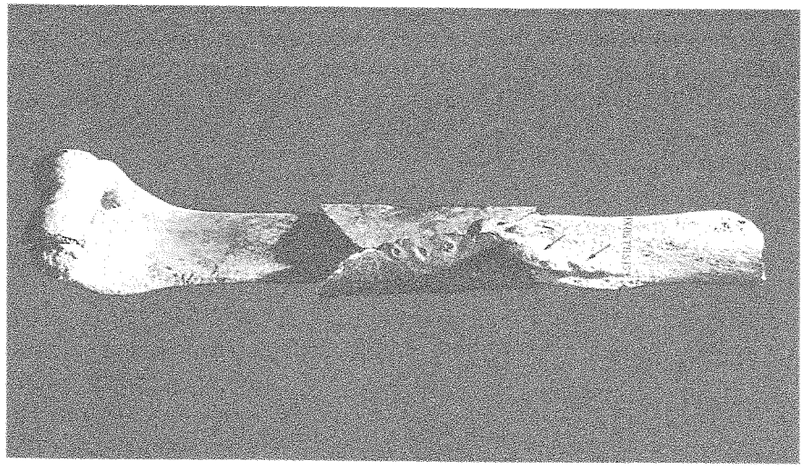

Figure 5. - Another example of a copper plate applied to a humerus of a subject buried in the Cistercian Abbey of Varnhem between 1260 and 1527 A.D. Note the large exostosis that is in part covered by the plate. The holes were to allow the passage of the pins that anchored the plate to the bone (from Hallbäck, 1976-77).

Figure 6. - Detail of the skeleton, showing the right humerus with a copper plate. Subject from the cathedral of Vrasene, Belgium, dated to between 1571-1650 A.D. (from Janssens, 1987).

dle Ages were applied for reasons other than those for which modern means of internal fixation are applied. If one excludes the improbable possibility that in all three cases all traces (including radiographical) of previous fractures disappeared, it appears possible that the plates were applied to the bones when they were infected (with osteomyelitis or periosteitis). The plates therefore served two purposes, to reinforce the skeletal segments that had been weakened by the sequestrae typical of osteomyelitis, and to act as powerful local disinfectants. Indeed, copper was well known in the ancient world as a disinfectant, and its topical use in surgery was specified by Celsus, among others. The antiseptic quality of copper (and, clearly, its oxides, in other words the various copper salts) would amply justify

Figure 7. - Detail of the copper plate applied to the subject shown in Fig. 6, following its removal.

the use of plates inserted locally so as to treat the sites of osseous infection (the first two cases) or to treat sites of infections in the periosseous soft tissues (in the third case, in which there are no traces of osseous inflammation).

These considerations aside, the degree of survival of the victims is astonishing. As was true for the more ancient cases we discussed previously, all of the patients discussed here survived for long periods following the surgical treatment, and present no evidence suggesting that their deaths, which frequently occurred years later, were related to the operations they underwent or complications arising from the operations.

Yet another case in which copper was placed in contact with the bone has recently been reported; here the copper was applied to the pelvis of a woman buried in the Renaissance cemetery of Sant'Egidio (Borrello, Chieti). Many loops of copper wire were wrapped around the woman's ilium, and, probably, her sacrum (Fig. 8). This may be a surgical binding of the sacral-iliacal joint following its breakage (which may have occurred, for example, in the course of delivery), but it is possible that the copper wire loops were applied before death[14].

Chronic osseous infections and fractures were not the only conditions to be subjected to orthopedic therapy in antiquity. Indeed, we have a rich record, both direct (from the bones

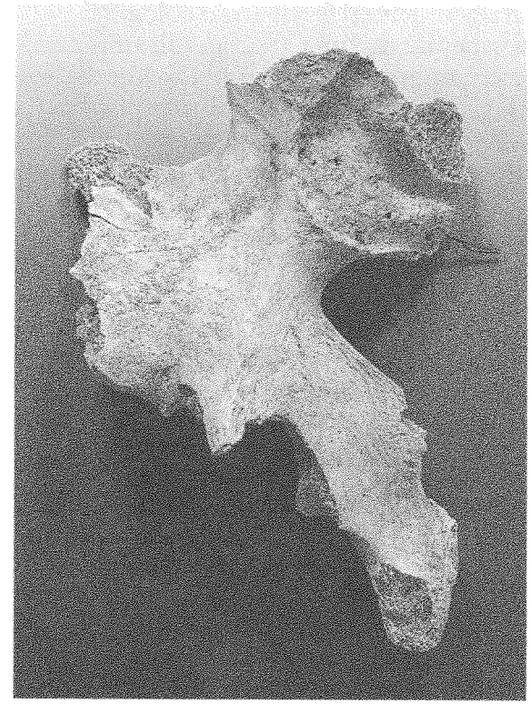

Figure 8. - Female pelvis with many loops of copper wire binding the sacroiliac joint. From the Renaissance cemetery of Borrello, Chieti, Italy.

themselves) and written, of therapies in other fields, that though orthopedic, fall outside the traumatological and anti-inflammatory domains which we have discussed so far.

For example, we know that amputation of the limbs was practiced, with success, at a very early date. A possible case of the amputation of the forearm with clear evidence of healing has emerged from the IXth Dynasty Egyptian cemetery of Sedment, which dates to 2,000 B.C.[15]. Certainly amputation was extremely common throughout the Middle Ages, especially in Central and Northern Europe. Only a small fraction of the amputations

that have been documented from archaeological sites were performed for therapeutic reasons. Indeed, the amputation of hands and feet was a common punishment in the Middle Ages, and the study of written records and skeletal remains has shown that the practice only died out in the 18th century[16].

There are, however, cases in which the amputation was most likely carried out for therapeutic reasons, even though this hypothesis cannot be confirmed absolutely.

The Medieval Moravian cemeteries of Mikulcice and Prusànski have yielded the skeletons of two subjects who both lived in 9th Century A.D., and who had, respectively, their left and right feet amputated. In both cases the amputations healed, as is demonstrated by the reabsorption and remodeling of the stubs of the bones (Fig. 9). Both subjects survived their operations for

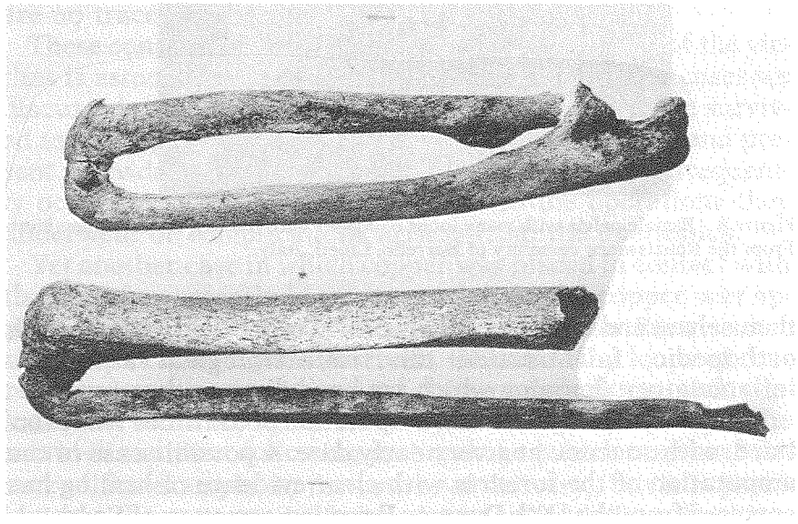

Figure 9. - Subject who suffered the amputation of the right hand and the left foot, from tomb 78 of the Medieval cemetery of Mikulcice, Moravia (from Stloukal & Vyhnànek, 1989).

Figure 10. - This is an example of the amputation of a lower limb slightly below the tibial tuberosity, certainly performed for therapeutic reasons. The subject clearly survived for a long period following the operation, as is shown by the advanced degree of reabsorption of the margins of the free ends of the tibia, and, to a greater degree, the fibula. The subject was an 18th century adult, whose remains were found in Gloucester, England (from Waldron & Rogers, 1987).

considerable periods of time, on the order of years, and neither displays evidence that allows one to correlate his death with the surgery he underwent. It is possible that these amputations were motivated by the presence of fractures, and that they can therefore be considered therapeutic treatments of people whose injuries were considered untreatable, for example serious fractures of the feet with vascular lesions and the development of gangrene in the soft tissues[17].

No matter the motivation for the amputations, the technique used had to be rapid and effective (Fig. 10). Indeed, of five Moravian subjects mentioned in the literature who survived the amputation of hands or feet during the Middle Ages (between the

9th and 14th centuries), only one suffered an early death, during the postoperative period. Again, the high survival rate of subjects who underwent complex surgical procedures under prohibitive hygienic conditions is astonishing.

Clearly, many other kinds of orthopedic treatments can be examined through the study of ancient human remains. However, this short would like to show that the direct record of history of medical practice, assumed by paleopathological findings, extends back over many thousands of years, in a balance between anthropology, datation of human evolution, observation of human diseases and early medical intervention[18].

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