The oldest amputation on a Neolithic human skeleton in France

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While 'surgical ' practices such as trepanations are well attested since the first stages of the European Neolithic, the amputation of limbs in Prehistoric periods has not been well-documented until the case presented here. The particularly well-preserved remains of an aged male were recently uncovered in the Neolithic site (4900-4700 BC) of Buthiers-Boulancourt in the vicinity of Paris, France. It was already noticed *in situ* that the distal part of the left humerus was abnormal and this led us to the hypothesis of a partially healed 'surgical' amputation.

The further investigations reported here confirm a traumatic origin and a partial cicatrisation after surgery, indicating that the patient survived. It also proves the remarkable medical skills developed during Prehistorical times. In addition, the associated grave goods are original, including the skeleton of an animal, a polished schist axe and a massive 30 cm long flint pick. Despite the serious handicap from which he suffered in this pastoral-agricultural community, the buried man obviously enjoyed some particular social status, as suggested by the remarkable and 'prestigious' accompanying grave-goods. If indeed this man benefited from some form of community care, this would indicate the level of social solidarity in Western Europe almost 7000 years ago.

This paper reports the exceptional discovery of an amputated Neolithic man, buried some 7000 years ago with remarkable grave goods. Indeed, among the c. 2500 burials known to us from the Linear BandKeramik (LBK) and post-LBK culture area, spanning

through the loess and silt soils of Western, Central and parts of Eastern Europe[1], such surgical practices have never been really confirmed by archaeologists.

This discovery occured at the Neolithic site of Buthiers-Boulancourt (France), a site identified in 2003 in the framework of preventive archaeology, when a trial-trenching evaluation was carried out prior to the expansion of a sand quarry. Situated some 70 km south of Paris, this site was occupied by agro-pastoral farmers widely described elsewhere[2]. Two dwelling areas have been evidenced during the two seasons of study in 2003 and 2005 (A.S. in preparation). The largest area (about 1 ha) includes six « Danubian » dwelling houses on a pattern evidenced "from the Seine and to the Dniestr"[3], dated on ceramic grounds to the end of local Early Neolithic (Villeneuve-Saint-Germain group, 4900-4600 BC *i.e.* Late and post-LBK Culture in the general context of the Neolithic in Western and Central Europe's Neolithic)[4]. The second dwelling area, smaller in size, has been identified as belonging to the beginning of the Middle Neolithic, i.e. the Cerny culture (4600-4200 BC), which corresponds to the "Stroke ornamented pots" culture of Central Europe[5]. The Early Neolithic dwelling area also yielded two small sepulchral groups with individual pits characteristic of this period[7] with respectively two and three burials, as well as an isolated incineration, a rare occurrence in the Early Neolithic of France (A. S. in preparation).

The burial that concerns us is part of the second sepulchral group, and located at only few metres from ovens and a lateral pit. The age of the tomb established by 14C dating at 4900-4710 Cal. BC (GrA-30913: 5920+- 40 BP. Groningen, Centre for Isotope Research, University Groningen, Netherlands) matches that of the other burials of Buthiers et Boulancourt, particularly the neighbouring burial of an old woman dated to 4830-4610 cal B.C. (GrA-31022: 5860+-BP. Groningen, Centre for Isotope Research).

The tomb consists of a particularly large and deep oval pit (dimensions: 2, 50 x 1, 60 x 1, 50 m), which has been directly dug out in the hardened calcareous ground. The robust male skeleton is oriented East-West, head East and facing South, like most contemporary burials in Western Europe[8]. Also the position is characteristic of the period: the individual is lying on his left, in a crouched position, lower limbs flexed leftwards, and knees over elevated. The feet are brought or possibly loosely held together at the ankles. The right upper limb is also flexed with a hand nearby the left shoulder. Ochre was spread only under the skull. The alignment of the right side of the skeleton – elbow, great trochanter and foot – indicates a board-like surface. The linear charcoal print observed at that place reinforces this impression. Some disarticulations and moves unrelated to later burrowing confirm that the body's decomposition has occurred in an unclogged space, as in a box or a coffin propped up by several stones and a grinding-stone fragment. Thus the right femur and patella have disarticulated and fallen into the pit bottom. The position of the right tibia and fibula, kept in balance by the left femur, is anatomically impossible in regard to the left limb. There was no silt to keep the knee in high position and bones have thus collapsed. As the right foot did not follow the rest of the limb, and is still over elevated, something was present holding it. The left foot confirms this observation with a position in balance, articulation preserved, whereas the right foot slightly collapsed backward. A corpse deposited into a supple material such as a sheet made of mat, skin, leather, or wooden bark could account for the foot position.

Although most known examples of such funerary practices are dated to Middle Neolithic, at least one case of this kind has already been observed at the nearby Early Neolithic site of Vignely[9].

The skeleton is affected by numerous osteoarthritis deteriorations, particularly important on vertebras, from the cervical part– especially the eburnation of the axis

extremity - to the lumbar region. Main lesions are *inter* apophysis, with the yellow ligament ossified. Lower limbs are also damaged, especially the knees and feet articulations. One of the thoracical vertebra is cracked by a Schmorl's node, which is a herniation of the cartilage of the intervertebral disc through the vertebral body endplate and into the adjacent vertebra. If the vertebra is poorly preserved, the node bank is clearly visible. Other pathologies affect the maxilla and mandible with the loss *ante mortem* of all the teeth. The cavity resorption is sometime incomplete, and several parts of the bone show infections.

The funerary assemblage

The exceptional funerary assemblage found with our amputated man is unique amongst the numerous burials excavated throughout the LBK area. The sepulchral goods include the deposit, at the feet of the skeleton, of a complete young animal (ovid or caprid, according to the zooarchaeological analysis by C. Bemilli, Inrap-UMR 5197) and also, adjacent to its skull, a 20 cm long polished axe in schist. In addition, a very large (30 cm long) bifacial flint pick, polished on both ends and partially on its surface, was perpendicularly placed on his left humerus.

During the Early Neolithic, tombs rarely if ever contain the deposit of a complete animal, as distinct from its parts (leg, mandible or skull). The significance of this domesticated animal raises questions: does it represent food provisions and/or an asset for the beyond? The schist axe is a completely polished artefact made of a flat block. Its shape is very narrow and elongated, with an oval section. It is significantly longer than the small-size specimens well known for this period and the stage after. During the early phase of Neolithic, tools such as axes are very rarely evidenced in the dwelling areas or in a funerary context. This object was thus very rare in Parisian Basin and therefore should be considered as a "prestige" object [10]. We cannot establish whether or not it was manufactured especially as a funerary offering.

The third item found in this burial is a flint pick which, just like the axe, was most probably never used. These tools appear in Western Europe at the very end of the LBK and become widespread by the post-LBK (round 4500 BC)[11]. Such an item must have been still very rare at Early Neolithic sites. It is noteworthy that, following ethno-archaeological observations[12], both axes and picks present a high absolute value, which would confer a peculiar status to this old man in his agro-pastoral community.

The amputation

The main particularity of this buried individual is the left humerus position, away from the ribs, and a total lack of bones of the left forearm, wrist or hand. The lack of bones or limbs is frequently observed on the archaeological skeletons, mostly due to taphonomical factors. Here in Buthiers-Boulancourt, the absence cannot be explained by poor conservation since the right limb is almost complete, including phalanges, as is the whole skeleton. The abnormality of the distal part of the left humerus was already recognised during excavation. The distal extremity had a very clear section localized on both *Epicondylus medialis* and *Epicondylus lateralis*. The section is oblique down and internally for the *Epicondylus medialis*, and down and externally for the *Epicondylus lateralis*, which may indicate a traumatic origin rather than a malformative one. More, the absence of progressive bone thinning at this extremity rule out any teratological hypothesis such as amelia, hemimelia and any other partial or complete congenital amputation. However, the smooth alteration of the surface should be relative to taphonomy. At least, taphonomical traumas are present but are definitely not responsible for the distal section: small protuberances on the bone part rather led us to suggest a partially healed amputation.

The first radiological and microtomographical examination showed that, despite diagenetic surface alterations that affected the cortical bone, signs of cicatrisation occur on the distal extremity, i.e. a layer of newly-formed cortical bone overlying the

primitive bone defect; the density of this new bone is superior to native bone. Dense images inside bone diaphysis are artifacts (sediments inside the bone) and not pathological.

The age of this cicatrisation before death is evaluated, due to the cortical thickness, to some months or years, indicating a long survival after this “surgical” performance. The macroscopic examination did not show any inflammation in contact with this amputation, indicating a relative non septic intervention. A comparison of diameters, thickness and bone densities of both humeral bones did not show any significative difference, indicating a mobile left humerus without any atrophy or decalcification.

The complete paleopathological examination of the whole skeleton did not show any other lesion (particularly traumatic) that could explain such an intervention. It is the first amputation evidenced in France and it is a complex and successful medical act. Some surgical interventions on bones are well evidenced in prehistoric periods, such as trepanations which entail removing a part of the cranial vault[13]. This undeniable surgical act has already been demonstrated in Mesolithic[14] and Early Neolithic[15] and becomes more widely developed during Late and Final Neolithic.

Discussion

The scanner imagery (4) and the 3D reconstruction (A. Mazurier and R. Macchiarelli) confirm the amputation of the arm (3). We clearly identify a remodelling of the bone on its anterior and distal end. It corresponds to the linear cortical bank and the section of the amputation already recognized in the field. As no definitive signs of infection are visible on the skeleton, we have been led to consider trauma as the most plausible origin. Two points need to be discussed here; the technical procedure employed in this ‘surgical’ operation, and the kind of trauma that led the 'surgeon' to cut precisely above

the trochlea. This part of the bone is actually extremely robust, especially if a flint tool is used, and it would have been much easier to amputate few centimetres away from the elbow articulation, on the diaphysis.

We thus assume that the trauma, whatever its cause, has partly torn away the limb and broken the bones, at least the forearm. The operation took advantage of this, by completing the amputation. But the medial pilaster with the remains of the very linear cut attest that the bone was not completely broken. This is not therefore an accidental amputation, but a real “medical” choice. A cortical fragment on the posterior side indicate the process: a cut was made from the anterior side and the weight of the forearm has caused the break of the last millimetres of the cortical, like a piece of wood. The arm was probably held upward to benefit from the maximal aperture of the elbow.

Given that this elderly patient survived, his Neolithic caregivers must have had good knowledge of the needs and means to prevent blood flow through staunching, disinfection and cicatrisation. Thus, some remarkably sophisticated medical skills were available 7000 years ago to keep societies in health.

Concerning the Middle Palaeolithic, hypothetic healed amputations have been mentioned on two Neanderthal skeletons (Shanidar I, Irak[16] and Krapina in Croatia[17]).

However, we have not found any mention of proven amputations in Early Neolithic times, but there are two presumed cases, attributed to the LBK Culture. The first is from Sondershausen in eastern Germany: among the 45 burials excavated between 1951 and 1955[18], burial 18 shows a skeleton globally in the same position as that of Buthiers-Boulancourt: on its back, lower limbs flexed on its left side, the right upper limb flexed with the hand on the left shoulder. The left forearm is absent. No perturbations were visible on the distinctive loess filling of the pit. While the graphic documentation is of poor quality the humerus diaphysis appears to be complete,

suggesting that the presumed cut might have been applied at the same emplacement as our humerus.

Another burial from the same culture was found at Vedrovice, in Moravia (Czech Republic). The site was excavated from 1975 to 1982 and revealed 110 tombs [19]. During the last campaign, burial 82/79 was found to contain an old man lying on his belly, with all the limbs flexed. The left forearm lies under the rib cage. The hand is absent as are the distal extremities of the ulna and the radius. The authors suggested a healed amputation, but in the publication no documentation or image illustrates precisely the bone extremities.

Even if no further examinations can confirm these suggestions, these two examples can suggest the existence of some elaborate medical practices over the whole Linear pottery culture of the European Neolithic.

Conclusion

This amputation is the first case evidenced for Prehistorical times in France and it is a successful surgical intervention that led to cicatrisation of the arm. Moreover, in spite of a very invalidating amputation of arm and some handicapping osteoarthritic backaches, this old man survived in this agro-pastoral community. This discovery confirms the existence at the time of some form of mutual aid and solidarity towards disabled people. To judge by the high value of the grave goods, this man seems to have benefited from some special status in the social hierarchy of this Neolithic community. The quality of rarely evidenced 'prestige' funeral goods, namely the pick and the axe, also confirm the skills of contemporary craftsmen. Their technological competence is not always perceptible when studying the flint assemblages attested in the dwelling refuse-pits. The unexpected attentions and technical competences in surgery given by this Neolithic

group towards one of their elderly and disabled member suggests a considerable level of social, medical and even moral development in Western Europe, some 7000 years ago.

Methods

The neolithic humerus and the modern humerus microtomographic records were performed at the University of Poitiers, France, with a X8050-16 Viscom model (respectivly on the 2007/02/26 and the 2007/03/04).

Scanning procedure: Both bones have been scanned by A Mazurier according to the following parameters:

Scanning parameters	Neolithic humerus	Modern humerus
Energy	120kV	100kV
Intensity	150µA	130µA
gain of the camera	75%	54%
integration number	16	16
zoom of the camera	mode 1	mode 1
projections	1800/360°, *i.e.* 1/0,2°	1500/360°, *i.e.* 1/0,24°
offset of the frame grabber	175	140
gain of the frame grabber	662	700

Neolithic humerus:

Reconstructed volume has a 1004x1004x1004, 8bits format with a resolution of 63.0637µm3. A ring artefacts correction has been done and the original uCT slices

reduced. The 845 final 8bits-tif format sections of 848x426 pixels have a resolution of 63.0637µm3.

Comparative modern humerus (coll. Univ. Poitiers) :

Reconstructed volume has a 1004x1004x1004, 8bits format with a resolution of 68.2275µm3. A ring artefacts correction has been done and the original uCT slices reduced. The 976 final 8bits-tif format sections of 897x434 pixels have a resolution of 68.2275µm3.

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Figures legends

Fig. 1- General view of the burial 416 (photography Inrap). Close to the skull, we see the schist axe and above the left humerus, the long flint pick. The domestic animal deposit, very poorly preserved is at the feet of the old man.

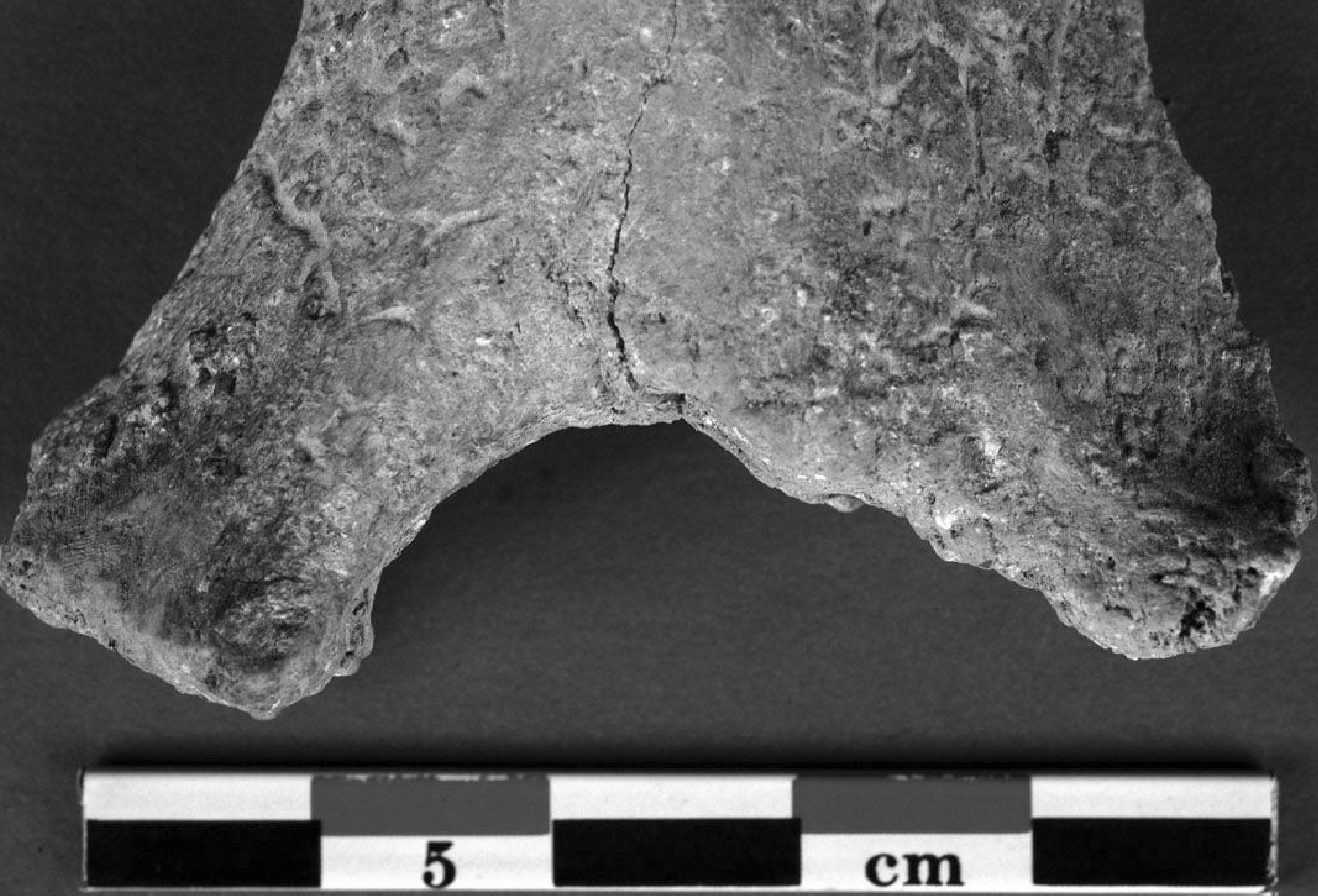
Fig. 2 – Detail of the amputated humerus (photography LDA CG 94). The end of the bone is clearly abnormal. The surface is rectilinear which indicate that the trauma did not tear completely the bone out. He needed a surgical operation to disarticulate the forearm, thus the Neolithics cut it, most probably with a flint tool that cause the rectilinear aspect.

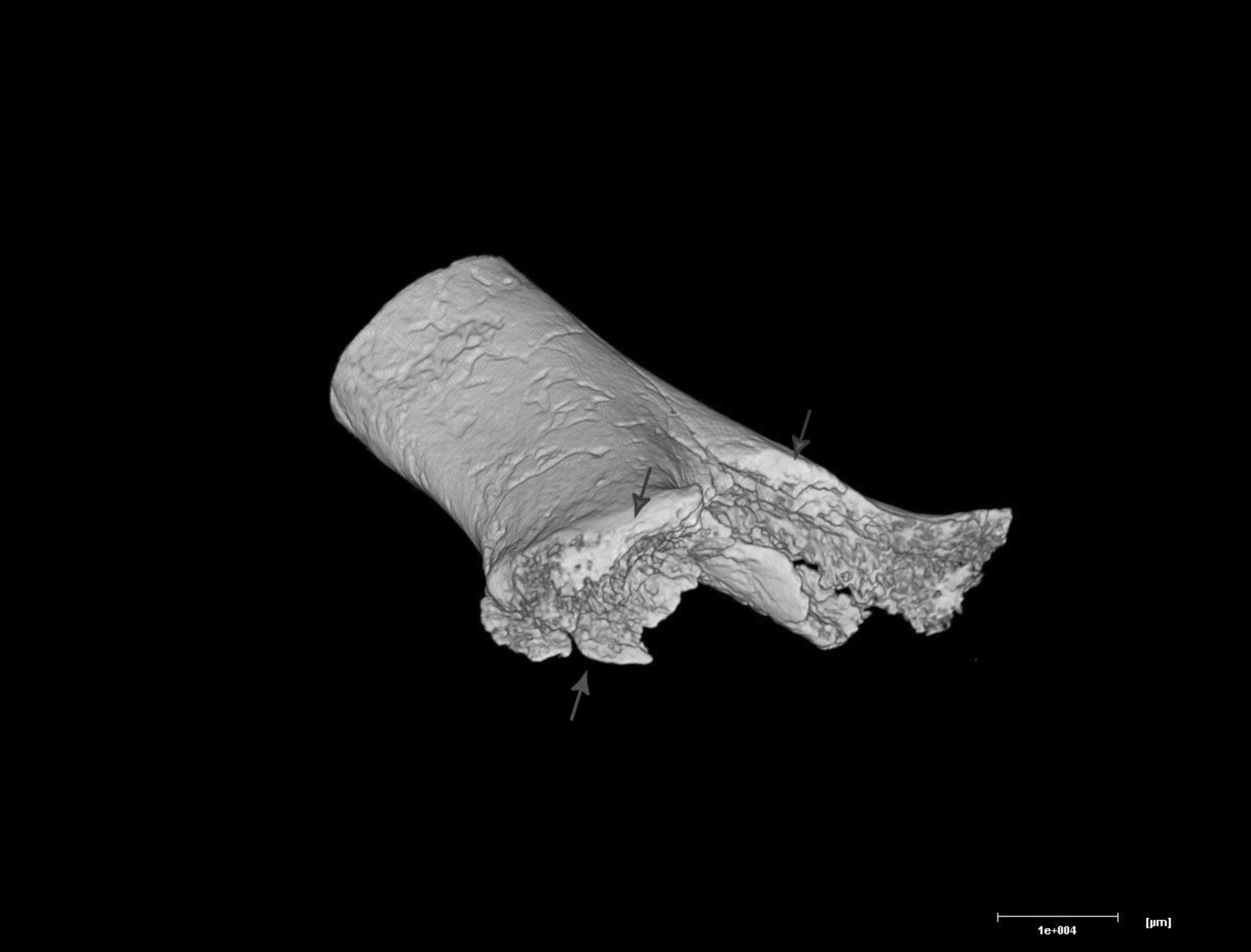
Fig. 3 – 3-dimensional computed-microtomography reconstruction of the humerus (realisation A. Mazurier), distal view. Taphonomic factors have damaged the skeleton and reactive bone developments are only partially preserved. It is extended on the anterior part of the bone end, on the olecranian part of the *Epicondylus lateralis* and on the *Epicondylus medialis* part (white arrows). This development is the sign of the healing and proves that the old man survives to the amputation. A cortical fragment on the posterior side indicate the way the prehistoric surgeons have proceeded to cut: from anterior side to posterior side (yellow arrow).

Fig.4 – Comparison of 3 microtomography reconstructions of the Neolithic humerus with a microtomography reconstruction of a modern humerus (coll. University of Poitiers, realisation A. Mazurier). We obser

ve on the upper slices the thin remodelling of the distal section (white arrow). On the lower ones, the yellow line indicate on the comparison humerus (right image) the amputation emplacement, the yellow arrows compares the olecranian hole between the *Epicondylus lateralis* and on the *Epicondylus medialis* part and shows its abnormal extension on the neolithic.

Fig. 5- Detail of the funerary deposit: a flint pick and a schist axe (Photography Inrap). These tools are exceptional in a burial of the beginning of Vth Mil. BC.

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