

MALUNITED SUPRACONDYLAR FRACTURE OF FEMUR IN A 2000 YEAR-OLD HUMAN SKELETON FROM PREI KHMENG, ANGKOR.

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Introduction

The purpose of this article is to describe the radiological investigation of a malunited supracondylar fracture of the femur in a 2000-year-old skeleton from Prei Khmeng site, Angkor, Siemreap, Cambodia.¹

Materials and Methods

Skeleton

The skeletal remains were unearthed in January 2001 at the excavation site of Prei Khmeng temple in Angkor region, province of Siemreap, Cambodia. The burial site had 7 human skeletons. One adult skeleton (referred from hereon as Bony I) was lying stretched on its back in an East-West direction, with head turned towards the East (Figure1). A Carbon-14 isotope dating of charcoal found in the stratum confirmed that the skeleton is approximately 2000 year-old. Despite the fragmentation of the skull and pubis, the morphometric analysis of long bones clearly indicates that the skeleton was that of an adult female. The entire skeleton almost completely recovered by its soil matrix was cut into 11 blocks and transported from Cambodia to the National University Hospital, National University of Singapore, Singapore for a scientific investigation.



Figure 1 (a, b): Bony I at the site of excavation. Note the smooth bowing of the lower end of the right femur. Close up view of the malunited fracture of the right femur (b)

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Imaging

Each block of Bony I were cleaned separately. The soil was carefully removed to free the bones from the thick blocks of clay. The bones were not fully cleaned, but were cleaned enough to adequately x-ray the material, as presence of soil more than two or three centimeters severely hinders good x-ray imaging. Intensive cleaning results in further damage of the fragile material and dis-articulation of many of the joints, which was avoided after the first cleaning. After the first cleaning the blocks were subjected to x-rays and CT-scanning. Following the CT scan, each block was carefully cleaned. After complete cleaning, the CT scan was performed again. Bones and bone fragments were kept in an exploded view as much as possible, labeled separately, bagged separately, and the information entered into a database. Information on bone fragments that conjoin with other fragments was also entered. An ongoing journal was maintained and data entered about each step of the process for future reference.

An antero-posterior and lateral X-ray of the block containing the distal right femur and knee was done after cleaning the skeletal specimen from its soil matrix. The block (Figure 2) was then scanned by a multidetector CT scanner (Siemens, Forchheim, Germany). The images were acquired at 140 KV; 150 mAs (milliamperere-second); field of view 280mm; beam collimation of 1mm and a pitch of 4; scan time per rotation of 0.75 s. The distal femur and knee after cleaning was scanned again with 70mAs and 120 KV. There was no gantry tilt for all the scans. The images were reconstructed with 50% overlap at 0.5mm and a field of view of 240mm. Both pre and post cleaning images were reconstructed on soft tissue and bone algorithms. On the Siemens Wizard console, multiplanar reconstruction (MPR) images, both pre and post cleaning, were created from the bone algorithm images. Data were stored and archived onto magnetic optical disks (4.8 or 5.2 GB) in loss-less JPEG format. Hard copies of specific images were printed when needed.

A correlation between X-rays, pre and post-cleaning CT was performed.



Figure 2: Block of the right knee with the malunited fracture.

Results

The pre-cleaning x-rays of the right knee block showed a bowing of the distal femur. No further details could be obtained due to thick soil matrix. The pre-cleaning CT images showed a malunited fracture of the distal femur (Figure 3a,b, 4), involving the supracondylar area. There were no lytic lesion within the trabecular bone or any periosteitis (thickening of bone) or any defect within the cortex that is perfectly smooth, uniform in thickness and continuous. There is an anterior bowing of (41 degrees) (Figure 2,3,4). The knee joint was normal. During the cleaning of skeleton, the distal femur and tibia broke into multiple pieces and there was no indication of the healed fracture. The post cleaning x-ray (Figure 5a,b) also did not show any evidence of fracture. The post cleaning CT did not add any significant information as compared to the pre-cleaning CT (Figure 5c).

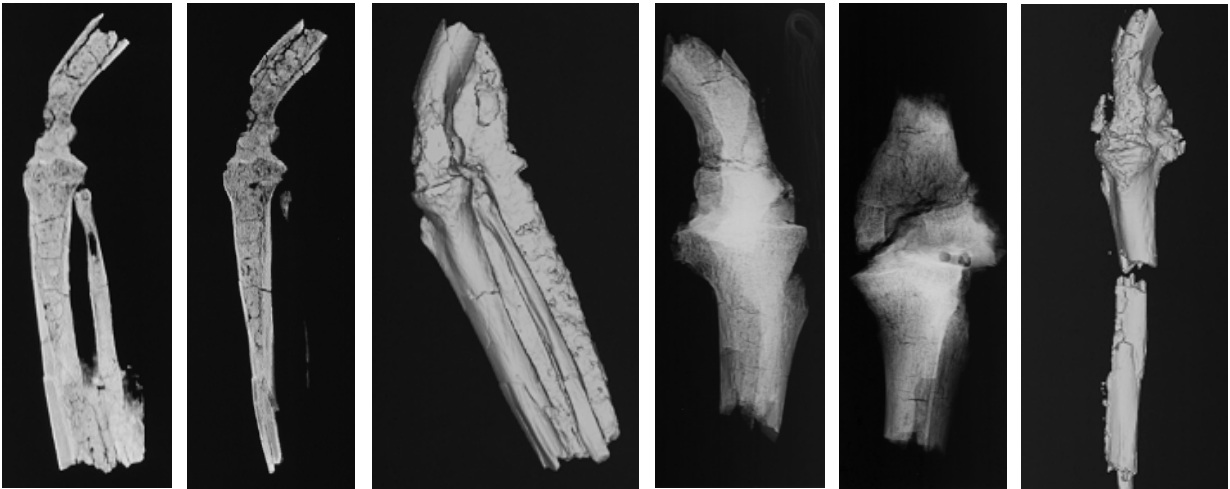


Figure 3: (a, b) Pre-cleaning CT of the right knee with multiplanar reconstructions. Sagittal multiplanar reconstructions showing the malunited fracture of the femur.

Figure 4: Pre-cleaning 3D reconstruction of the block. The bowing is well demonstrated.

Figure 5(a, b): Lateral and antero-posterior x-rays of the right knee post cleaning. Note fragmentation of the pseudofracture due to cleaning process

Figure 5c: Post cleaning CT with 3D reconstruction showing fragmentation of bone and loss of information about the fracture

Discussion

Skeletal remains and teeth are often the primary sources of paleopathological data. The quality of a radiograph depends on the tissues and material surrounding the skeletal remains. If the soil matrix has the same radiographic density as the skeleton, then the interpretation of the radiograph is very difficult. CT scan has been used as an investigation tool in the study of ancient human skeleton [1]. CT is proving to be a tool for creating a virtual archaeological library and allows preservation of the skeleton [2]. In our case, both plain films and CT have been performed to assess the bowing of the femur and the rest of the skeleton.

Bowing of a long bone can be secondary many conditions such as trauma, infection, tumor, metabolic conditions like rickets, hypophosphatemia and hyperparathyroidism and congenital causes including faulty intrauterine fetal positioning and osteogenesis imperfecta.

In our case, there is no other radiological abnormality besides the anterior bowing of the distal femur. There is no periosteal reaction, no lytic lesion within the trabecular bone and the cortex. This is a solitary lesion. Therefore the bowing is unlikely to be due to systemic or general conditions.

Post mortem changes- pseudopathology can also lead to bowing. These occur when bodies are in poorly drained soils with high acid content with fluctuating temperatures and humidity. It can also be caused by soil compaction. These pseudopathological bowings usually involve multiple bones, have a posterior curvature, although single bone may be involved in the presence of a tree root or a rock. In our case there was one limb involvement and bone had smooth curvature with normal bone thickness, which is likely to represent a malunited fracture.

Fracture of the femur is rare in mainland Southeast Asia, as showed by previous study in Ban Chiang

burials [3]. In a total of 136 burials, there was only one fracture femur. There were seven healed fractures at other sites, one bone contusion, and one avulsion fracture. This last case has been found to be difficult to distinguish from an osteochondroma

The most important historical inference from this case is that people living in Angkor region 2000 years ago were able to treat major fracture such as a supracondylar fracture of the femur. The bonesetters were able to immobilize the fracture by using splint, and allow the fracture to heal. However, as expected traction was not known during this period, and thus explain why this fracture has healed in a wrong position. Also, the cause and mechanism of the fracture may be inferred from this case. A major trauma is necessary to cause injury to a very strong bone like the femur. This may have been caused by a fall from height or from a stilt house, or by a fight against wild animal. There was no definite evidence to determine the exact cause and mechanism of the fracture.

In conclusion, a case of supracondylar malunited fracture in a 2000 year-old human skeleton has been investigated by X-rays examination and CT. CT scan was useful to make the final diagnosis of a malunion in a healed fracture and to exclude an underlying lesion, such as an infection or a tumor that may have led to this fracture. The use of CT with 3D reconstruction has been highlighted with particular reference to preservation of pathological data and measurement information, which may be lost during the cleaning process for anthropological analysis.

References

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