D55 Radiological, Forensic, and Anthropological Studies of a Concrete Block Containing Bones: Report of One Case

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The goal of this presentation is to illustrate the potentialities of multislice computed tomography (MSCT) in forensic anthropology.

This presentation will impact the forensic science community by providing an example of forensic anthropological application of the MSCT. Multi-slice computed tomography (MSCT) is uncommonly used in forensic anthropology. This presentation will present a case of MSCT examination of a block of concrete containing bones. This exploration was performed with an anthropological aim in order to analyze the nature and the type of the bones.

Introduction: During demolition work of houses in France, workers found bone fragments at the surface of a concrete block. Local judiciary authorities asked the block to be analyzed. The forensic pathologist was asked many classical forensic and anthropological questions by the police: how many bones or bones' fragments were present within the block? Were the bones humans or animals?; If human, was it possible to determine the racial phenotype, the sex, the age, and the stature of the deceased?; and, How old were the bones? In order to answer to these questions, a multi disciplinary study of the concrete block and of the bones' fragments was performed with radiological, forensic, and anthropology studies.

Material and methods: *Imaging study* — The CT examinations were performed at the Department of Radiology, Hospital of Toulouse, France. The block of concrete approximately 42 * 37 * 17 cm in size was fully scanned with a multisection CT scanner using the following parameters: 120 kV, 200 mAs, 0.75 mm section thickness, and 0.5 mm increments. The images were reconstructed according to both soft-tissue and bone algorithms. The reconstructed spiral CT scans were transferred to a workstation for post processing. Maximum Intensity Projections (MIP) and Volume Rendering Technique (VRT) three-dimensional (3D) reconstructions were obtained. Based on axial CT scans, two- dimensional (2D) coronal and sagittal multiplanar reformatted images (MPR) were performed. The images and 2D and 3D reconstructions were studied by a radiologist also medico-legal anthropologist, prior to the removal of the bones from the concrete block.

Virtual Anthropological Study: To determine if bones were human or animal, medullar index was calculated. The medullary index is defined by the ratio: minimal diameter of the medullar shaft/diameter of the diaphysis at the same level. The major drawback of this technique is the necessity to have relatively well preserved long bone. For humans and anthropoid monkeys the medullar cavity is narrow compared to the transverse diameter of the bone. For human adult, medullary index is on average equal to 0.45; for human foetus, varying from 0.15 to 0.48; for human child, from 0.37 to 0.50. For current domestic animals the index is greater than 0.50: on average 0.55 for pigs, 0.66 for dogs, and 0.75 for chickens. To determine the type of bones, racial phenotype, and sexing the deceased, textbooks of anatomy and anthropology were used. To determine the age of the decedent, measures of lengths of long bones were performed, using classical abacuses and textbooks.

Dry Bones' Anthropological Study: This study was possible after the removal of the bones from the concrete block. The bones were carefully extracted from the block of concrete, guided by the indication of the MSCT using basic hammers and gravers. After complete extraction, the bones were partially restored and analyzed. To determine if bones were human or animal, classical macroscopical criteria used in archeology and anthropology was used. To determine the postmortem interval of these bones, a transversal cut of a well preserved long bone was made and macroscopical analysis of the external and internal walls of the shaft was performed. Furthermore, an ultraviolet-induced fluorescence analysis was performed.

Results: *Anthropological Studies* — In summary, internal and surface bones were identified:

- A mix of human and animal's skeletal remains,
- Identified human bones were:
  - Two sided femur,
  - One left tibia,
  - One left humerus,
  - One left peri acetabular region.

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Bones were badly preserved and dramatically damaged with absence of epiphyses or cartilages at their proximal or distal extremities.

Human skeletal remains were consistent with a child, from 8 to 13- years-old, with a minimal stature of 128 cm. Sex and racial phenotype determination were not possible.

The bones were interred in concrete after soft tissues disappeared and no anatomical connexion between different bones was visible. The concrete surrounded the bones, with no free space, in favor of a secondary closed space configuration. Some extremities of the bones had brown trace evocating oil. This evocated a secondary burial: secondary removal of the bones from the first (primary) burial after the complete putrefactive process and entire skeletisation.

The bones dating were evaluated at almost 100 years old by ultraviolet fluorescence.

The main hypothesis for the presence of human skeletal remains within the concrete was the secondary removal of bones discovered in a primary burial (soil), but not reported, by a previous owner of the house in which bones were found. This phenomenon is quite often encountered in practice.

Discussion: Forensic cases which involved paving materials, required special equipment and technical considerations. Exhumation of a concealed body is always a complex process best handled by a team of experienced death investigators. Use of heavy construction equipment for exhumation, including the pitfall of creating artifactual injury of the body, has been previously described. When the body is encased in paving materials, heavy equipment is necessary for handling the mass and resistance of the material. The effects of body disposal may include preservation of the body and its identifying marks, preservation of trace evidence and toxicology specimens, and the creation of a negative cast of the body. In several cases the cement provided a mold of evidentiary value that could be used to identify the decedent by fingerprints or other means. On the other hand, removing the body from the concrete may cause artifact. The hydration of cement is exothermic. As concrete cures, it may reach temperatures up to 79° for the first few days, resulting accelerated decomposition. After curing is finished the concrete may insulate the body from heat and air. In addition, damp cement is highly alkaline. Thus encasement in concrete may slow decomposition in some circumstances. Decedents encased in cement or mortar may be discovered by chance, following the confession of the perpetrator, through an anonymous tip, or during the investigation of a missing person's report. It is essential to examine the remains under optimum conditions, transporting the heavy cement or concrete blocks to the medical examiner's office for evaluation. This allowed for MSCT exploration to be performed before disturbing the cement encasing the decedent or the bones, as efforts to free them could be directed away from the remains. A multidisciplinary team approach was essential and involved the extensive use of consulting professionals in the disciplines of criminalistics, anthropology, odontology, and radiology. Consultants in the disciplines of anthropology, odontology, and radiology are particularly helpful in establishing the age of the decedent, and the presence of pre-existing trauma. MSCT has also already been used with archaeological purposes. Soil samples containing particular materials have already been studied by MSCT to better characterize its contents. Jansen et al. reported the study of ancient roman glass fragments in situ in blocks of soil. Only one previous report of the application of MSCT in the evaluation of skeleton in soil matrix has been published by Chhem. Contrary to mummies and fossils, studies of ancient skeletal remains do not exist because of the lack of fascination they procured, of their recent and current character. However, MSCT seems to have a potential important role as a non-destructive imaging test for skeletal remains that are embedded in soil or concrete matrix and as diagnostic imaging test for paleopathological lesions and for the detection of burial goods.

The estimation of the PMI of the bones was not possible with the MSCT techniques.

It is the first time, that MSCT is used to study the inner of a concrete block for an anthropological purpose. As presented, this technique is useful for the forensic pathologist and the forensic anthropologist. Dry bone study identified more accurately the type of bones and their sides. This can be explained by the bad conservation state of the bone due to taphonomical processes, concrete erosive action on the bones and the fact that bones were those from an immature subject, more fragile than adult bones. Furthermore, the impossibility of making VRT 3D reconstructions made difficult the surface morphology analysis which can be helpful in such cases. One advantage of the MSCT is the non invasive in situ study, without risk of damage for the bone. In this case,

the extraction of the bones was difficult and many bones fractured during their concrete removal. This was due to the vibration of the hammer and the bad state of conservation of the bones.

Conclusion: This study represents an initial attempt to scan skeletal remains that remained embedded in a concrete block in order to prevent disintegration of bones and joints because of their fragility. This approach seems promising and may help in rescuing qualitative and quantitative data that are sometimes irreversibly lost during concrete removal. It is of the utmost importance if one wishes to keep, for example, rare hominid fossils surrounded by calcium rich ground for further study without taking the risk of damaging the original specimen.

Concrete Block, Forensic Anthropology, Multislice Computed Tomography