

# Kha and Merit: Multidetector Computed Tomography and 3D reconstructions of two mummies from the Egyptian Museum of Turin

Maria Cristina Martina<sup>1</sup>, Federico Cesarani<sup>2</sup>, Rosa Boano<sup>3</sup>,  
Anna Maria Donadoni Roveri<sup>4</sup>, Andrea Ferraris<sup>1</sup>, Renato Grilletto<sup>5</sup>, Giovanni Gandini<sup>1</sup>

<sup>1</sup> Institute of Diagnostic and Interventional Radiology, San Giovanni Battista "Molinette" Hospital, University of Turin, Italy.

<sup>2</sup> Complex Operational Structure for Radiological Diagnosis, Asti Hospital, ASL 19, Italy.

<sup>3</sup> Department of Animal and Human Biology, University of Turin, Italy.

<sup>4</sup> Museum of Egyptian Antiquities, Turin, Italy.

<sup>5</sup> Museum of Anthropology and Ethnography, University of Turin, Italy.

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## Abstract

**The Mummies of the architect, Kha, (Suppl.843 I) and his wife, Merit, (Suppl. 847 I) belong to the XVIII Dynasty of ancient Egypt. They were discovered at Deir el-Medina, during the Italian Archaeological Mission directed by E. Schiaparelli (1903-1906). Recently they underwent diagnostic investigation with helical CT at the Molinette hospital in Turin in order to verify the state of preservation of the bodies and to increase our knowledge of the funerary objects inside the bandages. A whole body helical CT acquisition with a multidetector CT unit was performed. Thin slices (2.5 mm thickness, 1.25 mm reconstruction interval), followed by multiplanar and 3D reconstructions were obtained. CT allowed a careful evaluation of body conditions, stature, age, embalming technique, pathological findings (some of which not revealed by previous conventional X-ray studies), and it allowed confirming and evaluating the presence of foreign bodies-jewels in particular. Once more CT, especially supported by new post-processing techniques, confirmed its fundamental role in the non-invasive study of mummies.**

## Introduction

The embalmed bodies of Kha, "chief architect" (Suppl. 843 I, cgt. 13015) and his wife Merit, "Lady of the house" (Suppl. 847 I, cgt 13016) who lived during the XVIII Dynasty

(1460-1400 b.C.) were found in an intact tomb during the excavations in Deir el Medina performed by the Italian archaeologist Schiaparelli between 1903 and 1906. Since then, they are housed in the Egyptian Museum of Torino in a dedicated room with their funerary goods. Besides food, kitchenware, furniture, dresses and products for the body care of the "Lady of the house", a golden cubitus given by the Pharaoh Amenofi II to the architect was found in the site of the excavation and can be appreciated in the museum.

The two mummies, were found laying in wooden sarcophagus (still containing them), their faces covered by gilded cartonnage, the whole body wrapped with bandages of various thickness.

The external condition is quite good, although conservation problems arose especially with the mummy of Kha.

The bodies had been previously studied with conventional X rays in 1995.

In 2002 they underwent a whole body Computed Tomography (CT) in the Institute of Radiology of the University of Turin.

Purpose of the paper is to report the main findings of the CT evaluation, confirming and underlining the advantages offered by the most recent CT helical multidetector units supported by multiplanar and 3D reconstructions in the study of the mummies.

## Material and methods

In both cases a single whole body helical CT acquisition with a multidetector CT unit was performed, planning the acquisition on a digital radiogram (scout view).

A multidetector CT unit Qx/i General Electric Medical System (Milwaukee, U.S.A) was used, with the following scan parameters: 120 KV, 200 mA, scan time 0.8 sec., slice thickness 2.5 mm, reconstruction interval 1.25 mm, High Speed modality, bone and standard algorithms.

Post-processing with the evaluation of all the axial images, multiplanar and 3D reconstructions, including the virtual,

progressive removal of the bandages (virtual unwrapping) (Fig. 1), were then performed on two workstations: Precision 530 with 2.5 Vitrea software (Vital Images, Fairfield, IA) and Sun Workstation (Advantage Windows 4.2 GE Medical system).

In both cases a "CT report" was drawn up, considering the position and the state of conservation of the body, details of its different parts, thickness of the wrappings, presence and characteristics of foreign objects and jewels, anthropometric analysis and stature.

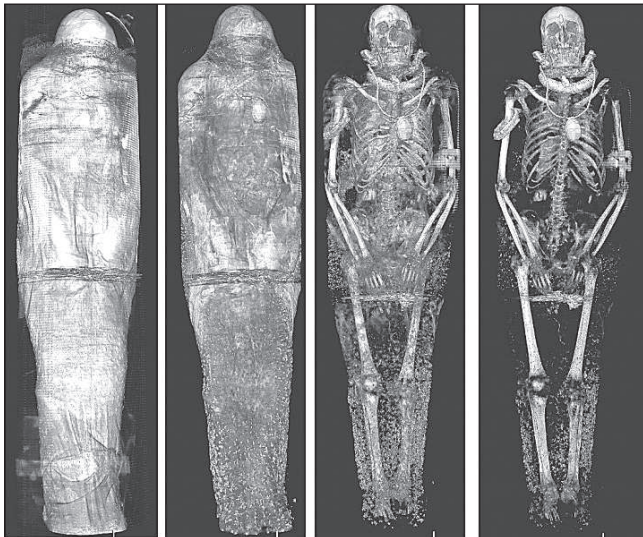


Fig. 1 - Virtual unwrapping of the mummy of Kha. The first default 3D reconstruction shows outermost surface layer of the bandages around the body. The progressive, virtual removal of layers of wrappings and soft tissues, selecting the structures according to their density, brings to the final, image of the skeleton and jewels.

## Results

According to the previous x-Ray images, the conditions of Kha's body were good, all the bones were intact, while, for Merit, several bone lesions caused by embalming procedures were found.

Among the bandages several metal, very likely golden jewels, were identified.

The x-Ray findings were confirmed, but the recent CT study allowed to obtain greater details on the general conditions, embalming procedures, anthropometrics, age, pathologies, amulets and jewels.

The most important CT findings are reported.

Kha is in supine position, the arms extended, the hands laid flat over the pubis.

The preservation condition of the skeleton is excellent. Dehydrated brain tissue is present in the lowest parts of the skull and there is no evidence of attempt of brain removal through the ethmoid.

The eye bulbs are still evident, the optical nerve and the ocular muscles can be identified.

There are no lesions of the mastoid, the ossicular chain is intact.

Dentition is poor.

Mediastinal structures, collapsed lungs, the diaphragm, the liver, kidneys and peritoneal folds can be easily identified on

axial images and multiplanar reconstructions (Fig.2). The gallbladder is filled with calcified stones (Fig.3)

Diffuse and severe signs of arthrosis are present in the spine and knees. The first lumbar vertebra is severely depressed as sequel of fracture during life.

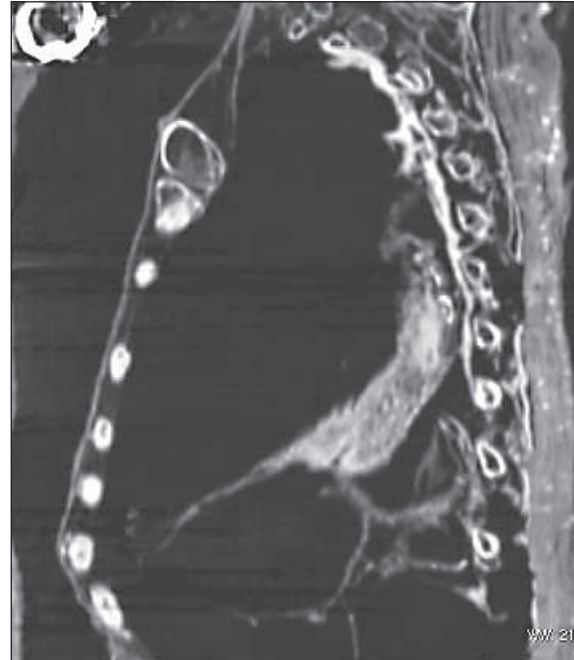


Fig. 2 - Sagittal reconstruction of Kha's chest. Mediastinal structures, the collapsed lung and the diaphragm are well visible.

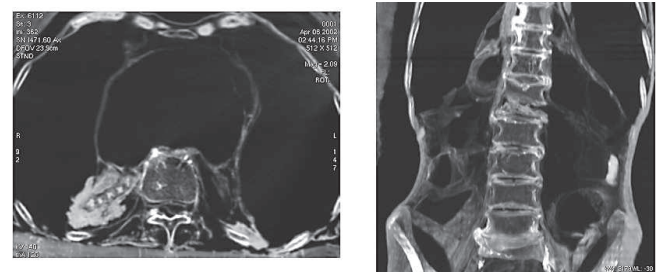


Fig. 3 - Axial and coronal images of Kha's abdomen. The liver parenchyma is dehydrated and the gallbladder is filled with calcified stones. In the coronal reconstruction the peritoneal folds can be identified, while no packages nor embalming material are visible. Severe signs of arthrosis and the deformation of first lumbar vertebra are evident.

Many arterial vessels show diffuse calcifications.

Stature, evaluated according to Trotter and Glaser formula (Trotter and Glaser, 1958) was estimated in 1.71m; the age of death approximately 60 years.

An unusual finding is the presence of a wide space occupied by air between the body and the bandages around the chest and abdomen.

The presence of metal, very likely golden collar, earrings and bracelet, identified on x-Rays is confirmed, but other less radiopaque amulets such as a scarab on the chest and the Iside knot on the front were carefully identified and reconstructed with post-processing.

Merit lies in supine position, the arms extended along the body, the hands nearly crossed on the pubis.

The skeletal condition is poor: many bones are broken and

displaced because of embalming procedures. The brain is present and there are no signs of attempt of brain removal through the nasal cavities. The eye bulbs cannot be identified, while in front of them radiopaque material with the shape of the eyes had already been identified with x-Rays. Dentition is relatively complete. Some teeth are missing, but few signs of attrition are visible. The severe displacement of the bones of the chest and pelvis does not allow an accurate evaluation of the inner organs. According to Trotter and Glaser formula, the living stature was 1.48 m. From the dental condition the age of death can be estimated in 25-30 years. Artefacts caused by high density do not allow 3D reconstructions of the jewels, but the digital radiogram allows to identify details much more carefully than former conventional x-Rays. A suggestive 3D reconstruction of the cartonnage and the skull (Fig.4) shows a good correspondence between the two and confirms the accuracy of the reconstructions that can be obtained from the actual CT helical data.

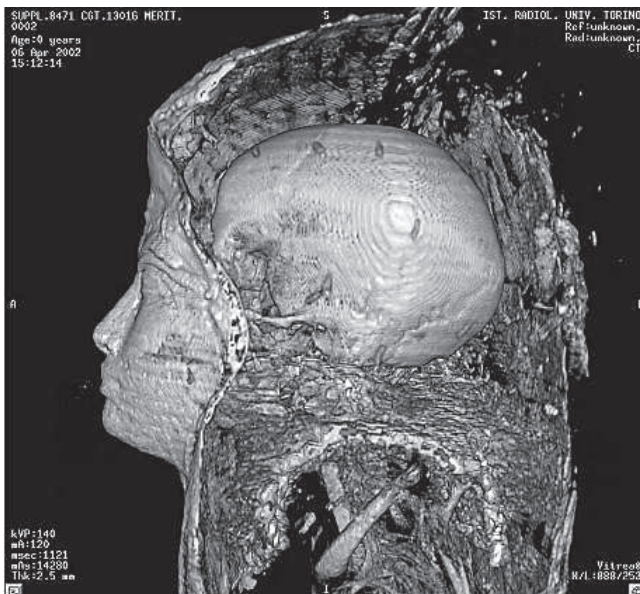


Fig. 4 - A suggestive 3D reconstruction of Merit's cartonnage and the skull, shows a good correspondence between the two and confirms the accuracy of the reconstructions that can be obtained from the actual CT helical data.

## Conclusion

In conclusion, the study suggests that Kha died old, affected by several diseases, probably fat and, although decorated with beautiful jewels, embalmed with a shorter procedure

than expected. A late reabsorption of fatty tissues seems to explain the empty space around the body, but this last hypothesis can be further discussed.

Merit died much younger probably of unexpected cause, as confirms the sarcophagus in which she was found, too big for her size and with the name of her husband. Also in her case not great care was used for embalming, but, despite these alterations, no significant disease was found. The evidence of the inner organs explains the mystery of the absence of canopic jars at the moment of the excavation, despite Schiaparelli reported an intact site. In agreement with the results of studies performed on other mummies by the same authors (Cesarani et al., 2003a, 2003b) and literature (Marx and D'Auria, 1988; Melcher et al., 1997; Bou et al., 1998) CT, supported by new post-processing techniques and the multidisciplinary cooperation among anthropologists, paleopathologists and radiologists, is fundamental in the non-invasive study of mummies.

Compared to less recent studies (Marx and D'Auria, 1988; Melcher et al., 1997; Bou et al., 1998) helical multidetector CT allows the acquisition of the whole body with thin slices from which very suggestive and interesting multiplanar and 3D reconstructions can be obtained. It is likely that in a recent future, more powerful CT scanners with thinner slices will allow even more accurate images.

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