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# Multifocal bone lesions in an ancient Egyptian child mummy

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ABSTRACT

Ancient mummies are very valuable human remains especially for the study of the evolution of disease. Non-invasive imaging methods such as computed tomography and X-ray are the gold standard to study such precious remains. We report the case of an ancient Egyptian child mummy from the Musée d'art et d'histoire in Geneva, Switzerland with multifocal sclerotic bone lesions affecting the spine and the left hip. The mummy is of unknown provenance, dating to the Roman period with an estimated age of 4–5 years. An infectious origin of the lesions such as tuberculosis seems most likely. Also regarding the time period an infectious etiology is plausible, since there is evidence that tuberculosis was wide spread in ancient Egypt. However, multiple differential diagnoses are discussed, since the evaluation of disease in ancient remains is different to the clinical standards. Medical history and additional invasive investigations are lacking. Also the desiccation and mummification processes lead to alteration of the tissue resulting in anatomico-morphological distortions. Thus our hypothesis can not be proven and multiple differential diagnoses need to be taken into consideration in this rare case.

## 1. Introduction

The value of historic human remains for the study of the evolution of human morphology and disease patterns is widely recognized (Bosch, 2000). Preserved tissues are the most direct source, in comparison to secondary sources such as visual or written records.

Ancient mummies are an especially rich source for the study of disease in former times. They originate from different cultures and time periods, and in comparison to skeletal remains, mummies are composed of preserved soft tissue (Cockburn and Cockburn, 1980). This allows for the study of a wide spectrum of diseases, including those of infectious, vascular or neoplastic etiologies (Aufderheide, 2003; Lynnerup, 2007). Hereby novel disease concepts, such as the evidence of arteriosclerosis in Peruvian and Egyptian mummies, as recently demonstrated, might change our understanding of modern civilization disease (Thompson et al., 2013).

In order to investigate such valuable historic remains, non-invasive diagnostic tools are required. For skeletal, and especially mummified remains radiological analyses are the methods of choice with conventional X-ray and computed tomography (CT) as currently the gold standard. In the case presented herein, a CT was performed to estimate age and sex, as well as to record *intra vitam* pathologies and post mortem changes.

An ancient Egyptian child mummy from the Musée d'art et d'histoire in Geneva, Switzerland, Accession-no: D 404 (Ritschard, 2003), was radiologically investigated (Fig. 1a). The original provenance of the mummy is unknown. It was donated to the museum by Walther Fol (collector and patron; 1832–1890) and arrived at the museum in 1865. The mummy is embalmed and bandaged and wears a mask. The height is 94 cm. According to the hieroglyphs on the shroud the child mummy dates from the Roman period (30 BCE–390 CE). However no C-14 analyses have been performed.

## 2. Material and methods

The child mummy has previously been investigated by X-ray and CT in 1983 (Hauser and Ody, 1983). In order of significant technical improvements the CT-scan has now been repeated. For radiological analyses a CT scan was performed at the Geneva University Hospital (HUG), Switzerland on a clinical CT-scanner (Biograph 64, Siemens, Erlangen). Several acquisitions have been done with variable imaging parameters; 0,6 respectively 1 mm slice thickness, 80 respectively 120 kV tube voltage, 198–475 mA X-ray Tube Current and 0,625 × 0.625-mm detector configuration. For post-processing including multi-planar reconstructions (MPR) and three-dimensional volume rendering (3D VR) reconstructions OsiriX–MD 64 bit (version

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**Fig. 1.** a) photo of the mummy, © Musées d'art et d'histoire, Ville de Genève, Switzerland; b) and c) 3D volume rendering images. Note the complete skeleton and the bracelets on both wrists.

8.0.1; Pixmeo, Switzerland) software as well as Sectra PACS (Sectra AB, Sweden) tools were used. Age estimation included dental status and the bone status of the hand, according to Greulich and Pyle (Greulich and Pyle, 1959). In order to increase the accuracy, the bone age of the elbow, knee and ankle have also been included (Brodeur et al., 1981; Hoerr et al., 1962; Pyle and Hoerr, 1955). In the present case the standard conventional radiographs for age estimation are not present, so the CT scans have been used instead, considering the beginning of carpal bone ossification seen on CT and the shape of the carpal bones as rough approximation. Sex estimation was based on possible remnants of genital organs.

## 3. Results

### 3.1. Radiological report

#### 3.1.1. General

The skeleton is intact and the mummy is bandaged and wears a face mask. Bangles are worn on both wrists, leading to artefact building (Fig. 1b & c).

#### 3.1.2. Cranium

The *lamina cribrosa* and the *cellulae ethmoidales* are damaged mainly on the left side, and the *lamina papyracea* of the left orbit shows a ca 10 mm defect; indicating a transnasal excerebration (Fig. 2a). The cranial cavity is empty apart from a small dense structure located in the right occipital region, probably a bone fragment, originating from the fractured ethmoid bone. A small round defect is seen in the temporal bone on the left side; it has well defined margins and has approximately a 10 mm radius. The lesion is wider on the inner side of the skull. A small bone fragment is seen in the same area. The overlying skin is intact. Another similar roundish defect of 5 mm radius is found in the left frontal bone, however in this area the overlying skin is missing (Fig. 2b–d).

The *clivus* and the *frontonasal suture* are not fully ossified yet. The nasal bone is fractured. The frontal sinus has not developed. However, the maxillary sinus, sphenoidal sinus and mastoid are all well pneumatised. The sphenoidal sinus shows a small lesion anteriorly. While the right orbit is preserved, the left orbit shows a small lesion in the *lamina papyraecea*. Remnants of the extraocular muscles, sclera and optic nerves are visible in both orbits. There are no other areas of interest in the cranial vault.

#### 3.1.3. Dental status

The dentition is normally shaped, caries-free and is comprised of a complete deciduous dentition (Fig. 3), and gives an age estimation of 4.5 years (e.g. the first permanent premolar has a complete outline of the cusps, the first permanent molar an initial root formation) (AlQahtani et al., 2010).

#### 3.1.4. Vertebral column and pelvis

The vertebral column is deformed probably due to the mummification process: the head is in extreme flexion and the dens axis is cranially dislocated towards the *foramen magnum*. This has resulted in missing lordosis/kyphosis in the cervical, thoracic and lumbar spine. Right convex skoliotic deformity is present. This leads to pelvic obliquity (right lower than left), resulting in a lower position of the right foot.

At thoracic level 8/9 there appears to be a frontal discus lesion and a slight dehiscence of the vertebra 8/9. In the sacral bone several dense structures are observed, which are likely to be penetrated embalming resin. Remnants of the dura and spinal nerves are present in the spinal canal. In the cervical part some bone fragments are identifiable, probably originating from the cranial lesions.

Multifocal sclerotic lesions affect the vertebral column and the left femoral head and neck (Figs. 4 & 5).

The lesions vary in size and are found in multiple adjacent vertebrae along the entire spine, with most notable lesions starting from C7