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Paleopathology of a 19th century mummy of a nobleman from Popoli, central Italy

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Abstract. A natural, well-preserved mummy belonging to a 35-40 years old male was found in the Church of the Holy Trinity in Popoli, Abruzzo region, central Italy. His fine clothes and burial location suggested that he was of high social status and had an important role in the church community. Most likely, he was a nobleman and a member of the Holy Trinity congregation. Two artifacts, a medallion and a relic of Saint Philomena, helped to date back the individual's time of death to the early 1800's. To conduct scientific analyses the body was secured to a cardboard layer by a plastic film and submitted to external examination, digital radiology, and computed tomography scanning, as well as histologic examination of samples obtained by video endoscopy. Anthropological investigations allowed us to observe pathological conditions as poor dental health, pulmonary pathology and a left renal stone. The renal stone was endoscopically removed and submitted to binocular stereomicroscopy, scanning electron microscopy also with microanalysis and X-ray diffraction analysis. The ovoid mass measured 22x16x15 mm, showing surface spherical buds and a nucleus of sharp-edged crystals with concentric laminations. Chemical elements were C, O, N, Ca, P, K, S, Cl, Na, arranged in calcium oxalate monohydrate (whewellite) (90%) and calcium phosphate (hydroxylapatite) (10%). The stone composition indicates a high animal protein intake by the subject, confirming that he belonged to high social class. The co-existence of caries, without major arthritic changes indicates that this man lived a life free from extensive labour. In fact, his death appears to be related to infectious complications of renal urolithiasis.

Key words: Paleopathology, Natural mummies, Central Italy, Nephrolitiasis

Introduction

The Church of the Holy Trinity in Popoli (Province of Pescara, Abruzzo region, central Italy) was erected in 1500 by the lay congregation of the Holy Trinity and reconstructed in 1734 (1). In a side room near the altar, under the floorboards, there is a crypt conserving human remains in various states of preservation. Although a thorough examination of this room could not be carried out, the crypt appeared to contain the remains of at least eight individuals (2).

During a first preliminary exploration, one individual still in a wooden coffin, directly below the crypt opening, was discovered. The coffin lid was pulled slightly back from the head end and, once removed, revealed a well-preserved mummy covered in dust. Visual examination suggested that the body belonged to a well-dressed male, possibly a priest. The recovery of the body and the preliminary investigations were presented on an episode in a television series called "The Mummy Road Show" by the National Geographic Channel (3).

Here we present the final results from the complete paleopathological investigation of the mummy.

Materials and Methods

An initial nondestructive investigation with portable X-ray examination (4) was conducted inside the crypt. Subsequently, it was determined that further examination would require removing the mummy from the crypt. Thus, the body was wrapped in clear plastic film in order to secure it to a cardboard layer and minimizing the risks during its recovery. The mummy was moved to the nearby hospital to be submitted to digital X-ray examination and computed tomography (CT) scanning.

Direct radiograms in different projections were obtained with the digital system GMM Opera T. CT scanning was performed by using a Siemens Somatom Balance scanner with 1 mm thick sections, obtained at reconstruction intervals of 3 mm, at 70 mA and 130 kV, with maximum FOV 44.2 x 44.2 cm, generating a total of 754 scans. Tomodensitometric evaluations were carried out according to the Hounsfield scale. Sex determination was made on the basis of the morphological features of the pelvis and skull (5). Age at death was assessed on the basis of the dental wear pattern (6).

Video endoscopy was performed in order to remove a stone from the abdomen and to recover artifacts from the individual's clothes, as well as to obtain biopsies from thoracic organs. Right thoracic tissue samples were rehydrated using Sandison's solution (7-8) for three days. The rehydrated specimens were routinely processed to obtain histologic sections stained with hematoxylin-eosin, Masson's trichrome, Grocott's, and Ziehl-Neelsen stains. The abdominal stone was investigated with binocular stereomicroscopy (BSM) with a LEICA S8APO stereomicroscope, and scanning electron microscopy (SEM) with energy dispersive X-ray analysis (EDX) using a Philips XL30/CP scanning electron microscope equipped with OXFORD-IncaEnergy microanalysis. Multiple tiny fragments from surface and inner portions of the calculus were submitted to X-ray diffraction (XRD) analysis with a Philips X'Pert PW 1830 X-ray diffractometer.

Results

After a preliminary cleaning, the burial clothes appear to be made of fine linen with floral print covering the entire jacket, changing our initial hypothesis that the body belonged to a priest (fig. 1). These fine clothes and the burial location could suggest an important role of the subject in the church community. Most probably, he was a nobleman and a leading member of the congregation of the Holy Trinity. No sign of evisceration and/or surface manipulation of the body was noted. Mummification was likely due to the dry cool environment in the crypt.

Determination of sex revealed male features. Age at death was estimated to be 35-40 years.

X-ray examination showed a metallic artifact within the clothes at about left lateral waist level and a ring between the crossed hands of the subject. From a paleopathological point of view, x-ray revealed the presence of a renal stone in the left lumbar region (fig. 2). A lateral radiogram of the head, at the dental arches, caries as well as evidence of periodontal disease.

Total body CT scanning confirmed the presence of the kidney stone and the artifacts (fig. 3), also displaying postero-basal pleural adherences in both lungs, more pronounced in the right side. Additional CT findings

Figure 1. The mummy removed from the crypt, after surface cleaning.

Figure 2. Digital radiogram showing the metallic artifact at left lateral waist, the stone in the left lumbar region, and a ring between the hands.

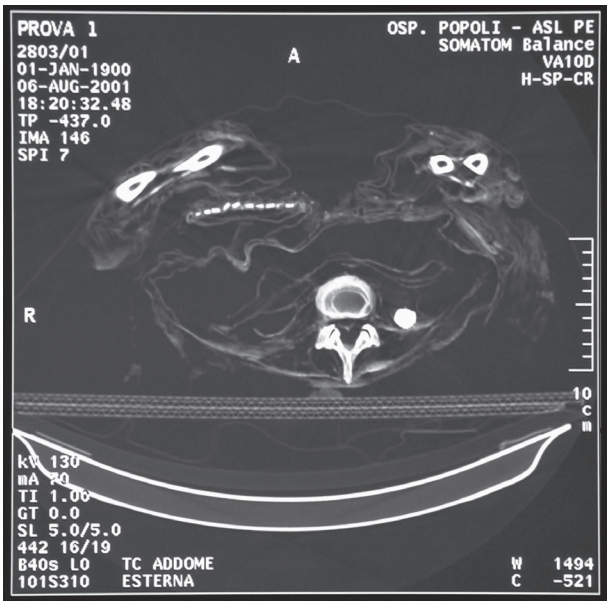

Figure 3. CT scan showing the stone and the metal artifact.

were represented by amorphous material (remnants of encephalic organs) in the posterior cranial fossa, along with portions of the meningeal tissue, also visible within the spinal canal. Tissue remnants were also present inside the orbits. Thoracic and abdomino-pelvic organs appeared extremely well preserved and readily recognizable. All these findings confirmed the natural mummification process, which appears to have been due to rapid dehydration, possibly related to the dry climate. Caries were recorded in first inferior molars, second right superior molar and third left superior molar. All inferior premolars have been lost *intra vitam*.

Video endoscopy found a small pouch among the folds of the clothes, which was removed and carefully opened. The metallic artifact inside the pouch is a medallion with the inscription and the figure of Saint Philomena. Additional items found in the pouch included an intricately folded piece of paper with an inscription referred to a piece of the shirt of the above mentioned Saint. Endoscopic biopsy from the right thoracic region, along with subsequent histologic examination of the specimen revealed fibrous tissue with calcification, fibromuscular tissue, fungal spores attached to the fibrous tissue, and presence of ectoparasites (fig. 4 A, B).

The stone extracted under endoscopic guidance was a brownish ovoid mass with small superficial spherical buds and measured 22 x 16 x 15 mm (fig. 5). The external surface, examined by BSM and SEM, showed a central core with small spherical nodules. The cut surface, observed with BSM, showed a central nucleus composed of sharp-edged crystals and various concentric laminations, pale and dark brown in color. Chemical elements detected with SEM-EDX were C, O, N, Ca, P, K, S, Cl, and Na. XRD analysis revealed

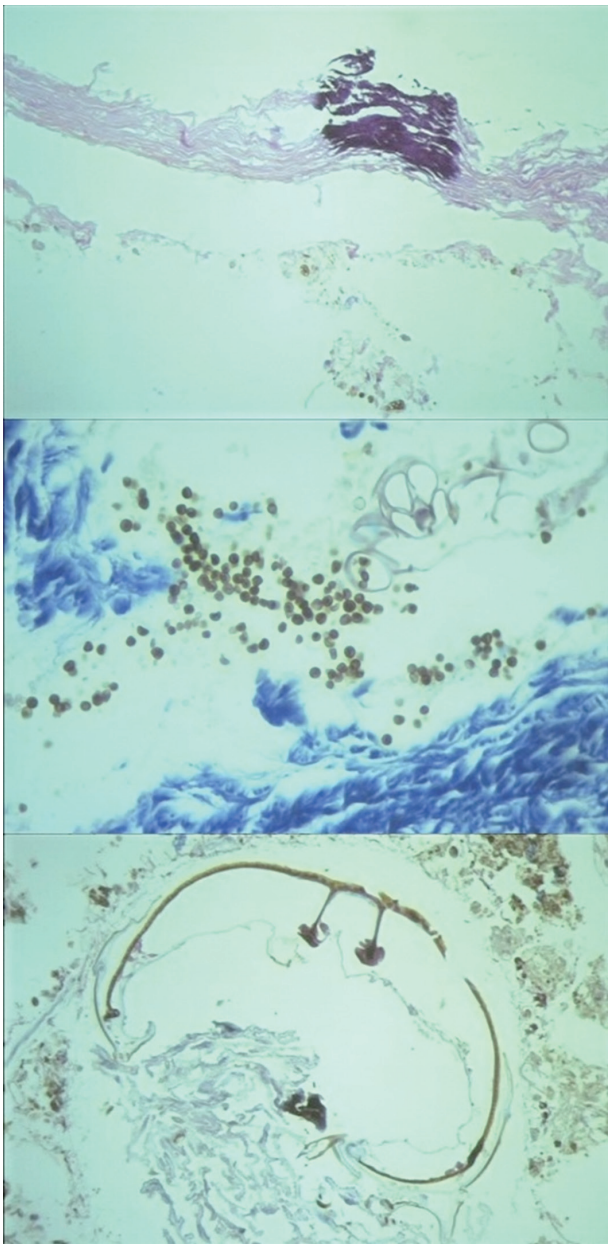

Figure 4. From above to below: calcified fibrous tissue (Hematoxylin-eosin, low-power magnification); fungal spores (Masson's Trichrome, medium-power magnification); ectoparasite structures (Masson's Trichrome, low-power magnification).

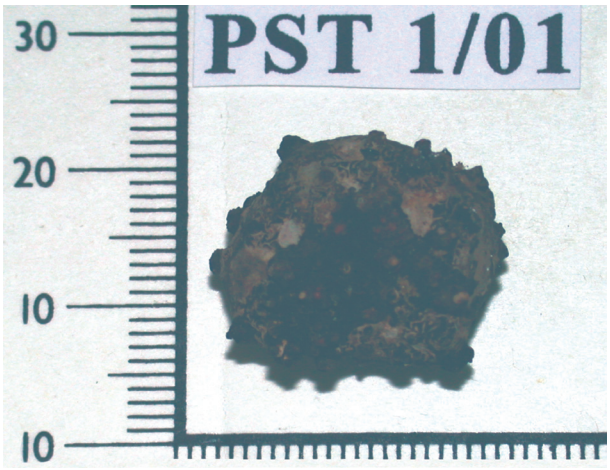

Figure 5. The brownish, ovoid stone with small spherical buds on the surface.

that the calculus was composed of calcium oxalate monohydrate (whewellite) 90% and calcium phosphate (hydroxylapatite) 10%. No trace of uric acid was found in this material.

Discussion

Several examples of mummified bodies were discovered in the inner Abruzzo region. Most of these spontaneous preservations are due to the cold and dry climate of this land. Historically belonging to the territory of L'Aquila and subsequently included in the Pescara province, Popoli is located in an area already known for preserving other examples of naturally preserved mummies (9-10). In this particular area, the important series of Navelli and Goriano Valli were also studied (11-12). As a matter of fact, the inner Abruzzo region should be considered one of the most relevant areas for natural mummification in Italy (13-14).

The discovery of the mummy of the Church of the Holy Trinity allowed us to apply several modern investigation techniques in order to carry out a complete paleopathological study of the subject. The analysis revealed considerable data regarding the social status, age in antiquity, sex, age at death, dentition, biomechanical stress, skeletal, pulmonary and renal pathology of this individual.

The preservation conditions of the body were evaluated through visual inspection and CT scanning. The presence of internal organs and the absence of filling materials or skin cuts allowed us to define a well-preserved, natural mummy, obtained by a rapid dehydration mechanism in cold environment.

The analysis of the medallion and the relic found inside the pouch of the clothes would highlight the significant role of the subject within the Church of the Holy Trinity. As important individual in the ecclesial community it had to be guaranteed to him, as to other members, the safe journey to the afterlife by including religious icons relevant to the times. People adopted Saint Philomena as their patron saint after the year 1802 and the cult spread rapidly to the southern Italy and Abruzzo region (15). This suggests that this burial may have occurred at the very beginning of the 19th century.

The subject was a middle-aged man, with dental, pulmonary and renal pathologies. The presence of significant dental caries and renal pathologies, without major arthritic changes (16) suggested he was not subject to extensive labor. Bilateral, basal adherences in lungs suggested recurrent episodes of pneumonia. The muscular bundles in the sample from the right lung indicates diaphragm muscle, and the presence of calcifications in such tissue is suggestive, but inconclusive for tuberculosis. Additional staining to demonstrate the eventual presence of acid-fast bacilli inside the calcifications gave negative results. The presence of fungal spores and hyphae is very common in mummified remains, and they may be easily confused with red blood cells even by expert pathologists unexperienced in ancient tissues (17-18). The ectoparasite more likely represents the result of a *post mortem* contamination.

The analyses of the removed calculus demonstrated that the subject suffered from renal stone disease. Urolithiasis is an ancient disease, the first paleopathological documentation of which dates back to the Paleolithic Age (19). At present, bladder stone disease is endemic in rural or impoverished areas, whereas renal stone disease is mainly an affliction of the industrialized countries of Western world (20). This explains the scarce mentions of renal colic from upper tract stones found in historical sources, and conversely the frequent references to bladder stones in the past (21). The diagnostic approach employed in this particular case is cutting edge, and enabled us to correctly diagnose

nephrolithiasis and to establish the type of renal calculus (19, 22). The chemical composition of the stone supports the hypothesis of high animal protein in the subject's diet, confirming once again that he belonged to high social class. In fact, a diet rich in proteins with small uptake of vegetables well explains the nephrolithiasis (23).

Unfortunately, also due to the lack of written sources, it was not possible to trace the identity of the subject but we could identify the cause of death. In fact, after our diagnostic reasoning, urinary sepsis may be considered the probable cause of death.

As prostatic hyperplasia is uncommon before the fifth decade of life and no other cause of urinary obstruction was found, a chronic illness such as chronic renal failure appears unlikely in this case (24). The death of the subject could be related to acute infectious complications of renal urolithiasis with or without hydronephrosis.

In conclusion, the mummy of this anonymous nobleman provided valuable information about the life and times in early 1800's Italy. The minimally invasive analysis coupled with a multidisciplinary approach revealed considerable data demonstrating the state of health of this individual at the time of death. The results obtained in this particular case are significant to the local community as well as to Abruzzo region, and should encourage the entire recovery of the Crypt to study the entire anthropological sample.

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