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The natural mummies of Popoli. A new site in the inner Abruzzo Region (Central Italy)

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Abstract The authors describe the preliminary investigation of the natural mummies found in the church of the Holy Trinity in Popoli (inner Abruzzo region, Central Italy) and dating back from 1734 to 1845. The project was featured as an episode in the National Geographic Channel series "The Mummy Road Show". The mummy of a male individual, 35-40 years old, underwent non-destructive examination with radiological, endoscopical, histological and X-ray diffraction analysis. The individual, belonging to high social class, was found affected by caries, paradontal disease, rib fractures, calcification of the diaphragm and renal urolithiasis. The recovery and complete investigation of the whole series of human remains will offer the opportunity to trace an anthropologic and paleopathologic profile of this interesting community.

Key words Popoli; Central Italy; mummies; paleopathology; renal stone.

Resumo Os autores descrevem a investigação preliminar das múmias naturais encontradas na igreja da Sagrada Trindade em Popoli (na região de Abruzzo, Centro de Itália) e que datam de 1734 a 1845. O projecto foi tratado num episódio televisivo da série "Na trilha das múmias" do canal National Geographic. A múmia de um homem de 35-40 anos foi submetida a exames não destrutivos através de radiologia, endoscopia, histologia e por análise de difracção de raios-X. O indivíduo pertencia a uma classe social elevada, tendo sido afectado por cáries, por doença periodontal, fracturas das costelas, calcificação do diafragma e por litíase renal. A recuperação e a investigação completa de toda a série de restos humanos permitirá traçar o perfil antropológico e paleopatológico desta interessante comunidade.

Palavras-chave Popoli; Itália central; paleopatologia; cálculo renal.

Introduction

The village of Popoli (250 m above sea level) rises at the junction of the Aterno and Pescara rivers, near the gorges of Tremonti (“three mountains”) (Figure 1). Originally called *Castrum Properi*, a name recorded since 1016, its history has always been dependent on the strategic position (the “key of the three Abruzzi”) along the main routes in the region, connecting L’Aquila and the adriatic coast to Naples.



Figure 1. A landscape of Popoli, near the junction of the Aterno and Pescara rivers.

Formerly belonging to L’Aquila, since 1927 it is included in the province of Pescara. Nowadays it represents an important agricultural (wine, cereals, olive oil, vegetables) and industrial centre (mineral water, beer) with about 5700 people. The springs of the Pescara river offer wonderfully clear and thermal waters, also used in the treatment of rheumatic pains. Enclosed between mountains, Popoli is a very windy place. It is known that Corradino D’Ascanio (1891-1981), the Italian engineer who invented the helicopter, was born here.

The church of the Holy Trinity in Popoli dates back to the Renaissance and was set up in 1500 by a religious congregation and subsequently (1734) rebuilt in today's form after an earthquake. During recent renovations the floor boards were removed from a side room just off the altar. Once removed, access to a crypt below the room was revealed. The crypt held several bodies in varied states of preservation with at least eight mummified and partially skeletonized bodies, together with additional human bone remains. As the ceiling is not high and the floor cannot be reached by superficial digging, the crypt may retain further individuals. The chronological dates of these human remains range from 1734 to 1845, when the cemetery was established in the village.

A preliminary investigation of the crypt took place last year. The research team was brought together through the efforts of the National Geographic Channel and Engel Brothers Media from New York City. The project was featured as an episode in a 13 part television series called "The Mummy Road Show".

The individual located directly below the crypt opening was found to be a well preserved mummy. He was still in a wooden coffin that was in a poor condition. The coffin lid was pulled slightly back from the head end and once removed, revealed a well preserved individual covered in dust (Figure 2). Visual examination suggested that the mummy was male and well dressed (Figure 3). It was initially thought that he may have been a priest since he was buried in the church and the clothes seemed to be similar to those which a priest might wear. After cleaning, the burial clothes proved to be of fine linen with floral print covering the entire jacket altering our hypothesis regarding the vocation of the individual. The fine clothes suggested someone of high social status and the burial location further suggests that he held an important role in the church. Mummification was likely to be due to the dry cool environment in the crypt supported by burial during the dry season.



Figure 2. After removing the coffin lid, a well preserved individual was revealed.



Figure 3. A well dressed male mummy.

Materials and methods

Initial nondestructive analysis was conducted in the crypt in order to preserve the context of any remaining tissue. Video-endoscopy was used prior to portable X-raying in order to ascertain if internal organs and soft tissue were present, and to obtain biopsies of any internal target organs. Video-endoscopy was successful in identifying organ and soft tissue remains in the thoracic region and biopsy of the right thoracic hemidiaphragm was taken. Portable X-raying was then conducted in the crypt using a researcher constructed frame to hold the X-ray tube. The crypt ceiling was arched with about 110 cm clearance at its peak. In order to eliminate the need for wet film processing, Polaroid instant photographic film was used. X-ray efforts were successful in collecting images of the mummy from the head to the pelvic region. Anterior-posterior views were taken. It was determined that further examination would require removing the mummy from the crypt.

The mummy was wrapped in plastic in order to secure the body to cardboard and minimize any movement. Subsequent X-rays and CT scan identified pathologies and artifacts (Figure 4). A renal stone was detected in the left kidney, confirmed by CT scans, and localized using Polaroid X-rays with spinal needles inserted at the approximate location of the stone. Antero-posterior and lateral radiographs were taken. One needle was introduced anteriorly with the other being introduced from the left lateral aspect. The localizing X-rays provided a guide for the excision of the renal stone under video-endoscopic guidance. Artifact localization was also accomplished via X-ray.

Right thoracic tissue samples were successfully rehydrated using Sandison's solution. The specimens were then embedded in paraffin to obtain 5 μm thick histological sections, stained with hematoxylin-eosin, Masson's trichrome and the Ziehl-Neelsen method. The renal stone (Figure 5) was examined microscopically and composition determined by X-ray diffraction.



Figure 4. Antero-posterior radiograph showing a renal stone, and artifacts (a ring and a medallion).



Figure 5. The renal stone measuring 22x16x15mm. The external surface shows a central core with small spherical nodules.

Results

A radiographic survey of the individual in the crypt using polaroid photographic film demonstrated a metallic artifact within the clothes at about left lateral waist level. The initial antero-posterior view was supplemented with a lateral projection to help localize the artifact. A video-endoscope was introduced along the left lateral side of the mummy among the folds of the clothes and found a small pouch, which was removed and an X-ray determined that the pouch did hold the metallic artifact. Initial impression based on radiographic appearance was that the artifact was a coin. The pouch was carefully opened and the metallic artifact was in fact a medallion with the impression of a woman and an inscription that identified the figure as Saint Philomena. People adopted Saint Philomena as their patron saint between the years of 1802 and 1810, which suggests that this burial occurred during that time span. Additional items found in the pouch included an intricately folded piece of paper with an inscription, which indicated that within the folds of the paper was a piece of the shirt of Saint Philomena. Additional items included what appeared to be religious artifacts and papers that were too delicate to examine at the time of this study.

Determination of sex was made using visual inspection, and radiographic analysis. A lateral X-ray of the head revealed a prominent brow ridge and mandible. A radiograph of the pelvis revealed male characteristics. Age at time of death was estimated to be 35 to 40 years. The estimate was made using dental attrition (Lovejoy *et al.*, 1985) and the presence of minor sclerosis at the superior aspect of the acetabulum bilaterally.

A lateral radiograph of the head revealed a poor dental status with caries present as well as evidence of paradental disease. Old multiple rib fractures were present bilaterally.

Endoscopic biopsy from the right thoracic region revealed fibrous tissue with calcification, fibromuscular tissue, fungal spores attached to the fibrous tissue, and presence of parasites. The presence of muscle bundles in the sample indicates that this is likely to be diaphragm muscle. The presence of calcifications in the tissue

is suggestive, but inconclusive for tuberculosis. No further evidence of tuberculosis was found in other anatomical locations. Alternatively, the hypothesis of healed trauma is to be considered. Additional staining to demonstrate the eventual presence of acid-fast bacilli inside the calcifications is being conducted. The presence of fungal spores and hyphae is common in mummified remains. The parasite could have been contracted while the individual was alive, but more likely is post mortem contamination, even though its final identification could not be made.

Extracted under endoscopic guidance the renal stone measured 22x16x15mm. The external surface showed a central core with small spherical nodules. The cut surface, observed with the stereomicroscope at 7x magnification, shows a central nucleus composed of sharp-edged crystals and various concentric laminations, pale and dark brown in colour. The X-ray diffraction analysis on the surface revealed calcium oxalate monohydrate (whewellite) 90% and calcium phosphate (hydroxylapatite) 10%. It was not surprising that the peak distribution was almost the same in a modern kidney stone tested as a control. No trace of uric acid could be found.

Discussion

The mummy provided valuable information regarding the life and times in early 1800's Italy. The nondestructive analysis coupled with selective biopsy revealed considerable data regarding the approximate age in antiquity, sex, age at time of death, as well as the life and state of health of this individual. The individual was middle-aged, had significant dental, pulmonary and renal pathologies. There were no major arthritic changes suggesting a life free from extensive labor. The death of the subject could be related to infectious complications of renal urolithiasis and hydronephrosis. Only a complete investigation of the abdominal tissue would be of help in confirming this evolution.

Artifact analysis suggests that the individual was important to the church community and he or his survivors wanted to assure

his safe journey to the afterlife by including important religious icons relevant to the times. The high social class of the subject is confirmed by the occurrence of renal urolithiasis, which notoriously affects well-nourished people with high intake of dietary meat.

The study demonstrates the flexibility of on site non-destructive analysis, using this data to target specific tissues or artifacts for additional study, which serves to preserve the individual for future research. The latter will include thorough endoscopical sampling of internal organs with histological examination, as well as paleonutritional studies, DNA analysis and microorganisms identification.

The church of the Holy Trinity in Popoli represent a new, interesting site identified in the inner Abruzzo region, an area of growing paleopathologic interest (Ventura *et al.*, 2001; Ventura *et al.*, 2002). The recovery and complete investigation of the whole series of human remains, along with their clothes and ornaments, will offer the opportunity to trace an anthropologic and paleopathologic profile of this small, but surely interesting community.

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