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Mummified remains in the field of forensics. The comparison of a 19th century case report with current cases

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Abstract. From the medical report published in the "Rivista Italiana di Scienze Naturali" in 1890 about a forensic examination conducted on two mummified fetuses, we discuss the interdisciplinary approach in forensic field. Already in this nineteenth-century case, we note how the multidisciplinary approach was able to answer certain questions. During the forensic investigation of a mummified body, a correct analysis allows to determine the era of death and causes of the mummification process, the manner in which the person died, whether it is related to homicide, suicide or a case of corpse concealment. The dialogue between the different disciplines (forensic pathology, anthropology, radiology, histology, entomology, archeology, psychiatry, etc.) is fundamental today as it was in the past in order to solve cases in the criminological field. We hope that the collaboration between the different sciences can grow again in the future.

Key words: natural mummification, mummification in forensic field, multidisciplinary approach, entomology, 19th century forensic investigations

Introduction

Forensic pathology, particularly in investigations related to mummified human remains, raises many problems and can not be separated from an interdisciplinary approach. It is often believed that interdisciplinary studies are a novelty. Instead, as demonstrated by the literature, both in the past and today, the multidisciplinary investigative approach that normally includes the forensic, biological, chemical, anthropological, archaeological, psychiatric sciences, etc., is fundamental to solve criminal cases (1).

From a medical-clinical point of view, mummies, and more generally, human remains, allow us to understand the origin and evolution of diseases (2-5).

With the term mummification, we usually mean a body that has been preserved both naturally and artificially. The English word "mummy" derives from the Persian word "mum" which describes the brown-black discoloration due to the resinous substance used to embalm the body (6). As an artificial *post mortem* process, we know that the Egyptians were the firsts to adopt the ritual of mummification to preserve the body and the physical features with the aim to identify the person's soul (7-8).

However, we want to exclude artificial mummification from our discourse because the tanatometamorphosis processes depends on rituality and beliefs not only for the natural conditions but also for the elapsed time from deceased to mummification.

The mummification process results from the dehydration of soft tissues. Massive dehydration and drying of soft tissues leads to mummification. During the mummification process, water is eliminated from tissue, avoiding bacterial putrefaction. Mummified tissues are rigid and dry.

To conclude the natural mummification process it normally takes between 6 and 12 months, but the time period of the process, in conditions of extreme temperature, can be drastically reduced (9).

When we talk about mummified bodies, we generally think of the past, the discovery of mummified remains in forensic contexts are rare and when this happens, it is necessary to determine the manner and cause of death.

Many examples of this type of natural conservation of the past have been discovered and have allowed us to understand what natural conditions have led to the conservation of tissues for many centuries (10).

Among natural mummies, we know of dehydrated mummies caused by the hot and dry temperatures (11-14).

Other particularly preserved bodies are the bog bodies, human remains, recovered in swamp lands in Denmark that dated back to the Iron Age (15).

The low temperatures, anaerobic environment and acidity of the water permitted this extraordinary conservation of the tissues even though the preservation of the skeleton is generally poor due to the mineral component of the bone being altered by the acidity of the bog (16).

In forensic cases, when a mummified body is found, it is necessary to make all possible assessments, of the way in which the person died, whether it is related to killing, suicide or a case of corpse concealment (17).

It is necessary to underline, as reported by the Laboratory of Legal Medicine and Anthropology of the University of the Côte d'Azur, that there is a deep discrepancy between the forensics of the mummified bodies discovered each year and the number of cases published in the forensic literature bringing to light a gap in the knowledge of this topic (18). In particular, the focus of the research conducted by the Laboratory of Côte d'Azur was to try to assess the minimum period needed to obtain mummification with the aim to date mummies using forensics. In this investigation, in which twenty mummified cases were examined, the researchers recorded that the minimum *Post Mortem Interval* (PMI) was three weeks (in an apartment) and the maximum was several weeks to five months. In forensic medicine literature, for mummification the shortest PMI for "extensive mummification" indoor was 4-6 months, while complete mummification required a minimum PMI of 18 months indoor (19).

The team of the Forensic Medicine of Chandigarh reported a particular case of a mummified corpse who had belonged to a man who died under the care of a mystic. The corpse was discovered in 1987, two years after his death. The autopsy examination together with the investigative information on the case made it possible to understand that the man had been deprived of water and food and the mummification was inevitable because of the heat of the month of June in the region of Chandigarh (20).

A case, reported by the Italian researchers of Rome, described the mummified body of an older man found walled inside an alcove in a sealed silicon bedroom, in a semi-supine position with his back on the floor and his legs against the wall. The son of the subject stated that after his father's death, he hid the body so to continue to claim his annual pension. In this case, the mummification had manifested itself in a special condition due to the absence of air (21).

It is evident that many cases, as mentioned earlier, have escaped both forensic literature of the past and modern day. It is expected that in the future an intensification in scientific sensitivity towards cases of mummification in the forensic field will guarantee greater interdisciplinary to obtain investigative information from the mummified body (22).

Case Report

Here, we report and discuss the legal and naturalistic medical considerations that had been published in the "Rivista Italiana di Scienze Naturali" by Doctor Corrado Lopez in 1890 about forensic examinations performed by Dr. Tebaldo Marini (23-24).

On October 23rd 1886, two mummified human fetuses were accidentally discovered in the attic of a house in Borgo S. Stefano near Volterra, one of the main city-states of the ancient Tuscan (Etruria) region in Italy (Fig. 1). The two fetuses - one a male, the other a female - were in a horizontal resting position and wrapped in dirty fabric on a very large piece of stone set against one of the walls. A scabbard had been re-

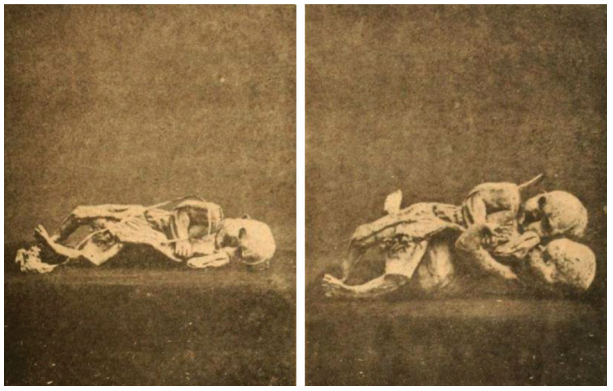

Figure 1. Photo of the two fetuses at the time of discovery. From Lopez C. Un caso di mummificazione spontanea. Rivista Italiana di Scienze Naturali. 1890;10(1): p. 7.

moved from a chair and laid on an inclined plane upon the fabric covering the fetuses.

The court instructed that the forensic examination be performed by Dr. Marini to ascertain whether the mummified newborn corpses had died of natural causes or infanticide (25).

The question had not been defined in an absolute way, the first hypothesis (the life of the newborns) had been considered the most probable, at least for the female foetus. The particular vertical position of the leg and of the arm of the female body made it probable, according to Dr. Marini, the contraction persisted in the cadaver.

When examining the fetuses, it was evident that parts of the body were out of place due to crushing forces. Also, in both fetuses and in both feet, there is a large interval between the fourth and fifth toe. The repetition of this divergence in both arts was attributed to an anomaly, rather than to a random fact.

Dr. Lopez then made his remarks on the mummification, which seemed to him to be due to a natural process. He reported that the bundle containing the two infant bodies was in this condition as it was continuously exposed to draughts as it had remained in the space between the vaulted floor and the vertical wall which, as it had been built 25 years earlier, had no plaster and consisted of porous yellow bricks.

The macroscopic and microscopic evaluations of the tiny bodies were made primarily to verify the spontaneous mummification, for this reason a critical examination of the theories of natural mummification was also considered.

In particular, Lopez criticized the hypothesis formulated by the doctors Zecchini and Pari, who had stated that the mummification of the two fetuses had been produced by the sole action of a fungus (suspected to be the *Hypha bombicina Pers*) already discovered by themselves in other natural mummies of Venzano (Tuscany). They stated that the parasite, when penetrating the skin, would make organic tissue more noticeable so they denied, as a rule, any influence of physico-chemical agents on mummification. In the two Volterra' mummies, which for three years remained in a dank room, no trace of Hypha, even microscopic, was found. Therefore, Lopez reported the conclusions of Marini that the mummification of fetuses had been caused by the incessant ventilation, the hygroscopicity of the stone, the rags in which the fetuses had been wrapped in, the drainage of cadaveric liquids in the gutter below the two bodies and finally the intensity of the cold environment.

Discussions

Today we are aware that when a mummified body is found in the forensic field, a multidisciplinary approach is needed together with a rigorous methodology, all to complete a correct diagnosis (26-27).

From a collaboration of the different research fields: forensic pathology, anthropology, radiology, histology, entomology, archeology, psychiatry, etc. it is possible to determine an accurate diagnosis.

Concerning the multidisciplinary approach toward the Italian natural mummies, the cases from the Church of the Dead in Urbania, central Italy (Marche), and from Roccapelago (central Italy) are representative. In the first case, the natural mummification is probably attributed to the mold *of Hypha bombicina Pers*. The mummies are displayed behind the altar and are placed in an upright position enclosed inside glass cabinets. These mummies belong to individuals who, probably starting from 1567, the year in which the Company of Death or Brotherhood of Good Death was established, were buried next to the church of San Francesco, in territory used as a cemetery. In the early 1800s, following the edict of Saint Cloud by Napo-

leon Bonaparte, the cemeteries were relocated outside the city walls for sanitary reasons, the bodies were exhumed from behind the Cola chapel (28).

The second case represents a natural mummification process probably due the extreme pH environment produced by the limestone-rich soil combined with "wicking" provided by the cloth burial wrappings (29). Even the mummies of Roccapelago underwent a process of natural mummification, favored by the particular dry and ventilated microclimate present in the environment below the church, that was used as a cemetery crypt and also where the bodies were buried (30). The presence of cracks in the outer wall of the crypt had in turn led to the recirculation of air, which contributed to keeping the environment dry and airy. The favorable conditions of the crypt that has hosted the bodies for centuries have therefore allowed the rapid evaporation of the organic liquids from the corpses, draining them in a short time and protecting them from putrefaction. The histological study showed that it is a natural mummification obtained thanks to a large and ventilated environment.

In the case presented here, Marini was convinced that the abandonment or infanticide, took place on a winters day. As clarified by Aufderheide the particular microclimatic conditions of the environments such as a perfect balance of different elements including cold and non-rigid cold, are mainly responsible for the rapid loss of fluids and soft tissue desiccation (11).

One aspect that makes this 19th analysis peculiar is the entomological examination conducted by Professor Visart to clarify the era of death or abandonment of the two fetuses. Visart did not find any trace of *Diptera*, therefore, as flies are the first to lay their eggs on corpses to initiate the course of cadaveric putrefaction, it is understandable to admit that particular conditions (such as tissue mummification) made it impossible for them to do so. Lopez also highlighted that the *Diptera* adults are present all year except in winter, so this reinforced the hypothesis of Marini, that the abandonment took place in winter, possibly in January as food in those places were difficult to source due to the harsh conditions.

The entomological investigations of that time revealed even more evidence as the presence of worms had been less than nine years.

Today, forensic entomology is very important in criminological context. By studying the insect population and developing larval states, forensic scientists can estimate the post-mortem interval (31). From the earliest stages, insects are attracted to the decomposing body and lay eggs in it. Using necrophagous fly larvae found over or near the corpse the forensic entomologist try to determine the date of death.

In this type of investigation, the correct identification of the species represents an important method of investigation in the practice of forensic entomology (32-33).

Diptera in particular belong to the main groups of insects of forensic entomology together with coleopterans.

During the rotting phase (2-7 days) a large number of *Diptera* are attracted to the corpse (34).

In the past, the key to identifying the species was simply the morphological examination of the insect. In recent decades, molecular methods are increasingly used for species identification (35). Another type of identification can be based on wing measurements. This method proved to be reliable in the case of some groups of *necrophagous diptera* coming from various geographical regions (36).

In addition, the DNA analysis in forensic science plays a very important role. Here, it is necessary to highlight the fact that experiments have been carried out on the study performed on mummified tissues with the aim of increasing the knowledge on post mortem degradation of DNA. The research, directed by the researchers of the Institute of Anatomy at the University of Zurich in accordance with medical ethics standards (37), was conducted on an amputated lower limb of an adult female 24 h post mortem (day 0) who had died of natural causes and was dried in with the natron as a procedure for Egyptian mummification. Skin and skeletal muscle were tested at multiple time points for a period of 322 days and subjected to genetic analysis. The outcome of the study reveals an excellent level of DNA preservation in mummified tissues with salt (38).

The autopsy, together with the entomological analysis and the parasitology science, helps to investigate the era of death and causes of the mummification process.

In the case of mummified fetuses presented by Doctor Lopez in 1890, the mummification process developed under specific environmental conditions and the multidisciplinary approach allowed to provide the answers.

From the story of this case, it is clear that the historical memory of an interdisciplinary approach in a forensic analysis represents a chance to reflect on the results achieved through the collaboration between the various disciplines. We hope that in the future this dialogue between different knowledge may grow again.

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